

AGRICULTURAL ENGINEERING

DECEMBER • 1954

In this Issue . . .

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Farm Tractor Tires

•

Hydraulic Expansion Principle Adapted to
Removing Dents from Irrigation Pipe

•

Effect of High-Frequency Electricity on
Gains in Growth of Young Chicks

•

Erosion Control Research Aids Develop-
ment of Soil Conservation Practices

•

Agricultural Engineers Develop Lightweight
Sprayer for Experimental Plots



THE JOURNAL OF THE
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

...for the changing pattern of plowing

CASE PIVOT ACTION



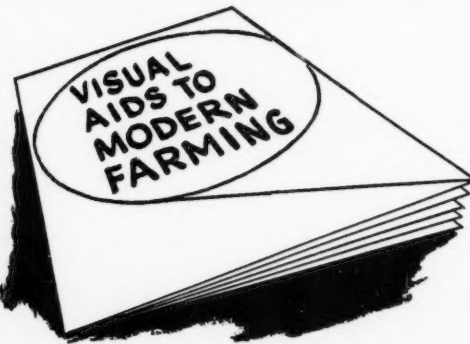
This amazingly simple feature stands as an example of truly progressive and practical engineering research . . . functional design that gives contour farming a new impetus, a new kind of accuracy for greater conservation benefits. Yes, pivot action, built into the implement itself just at the right point, permits these plows to keep all bottoms cutting at full width on curves . . . without skidding or increasing draft.

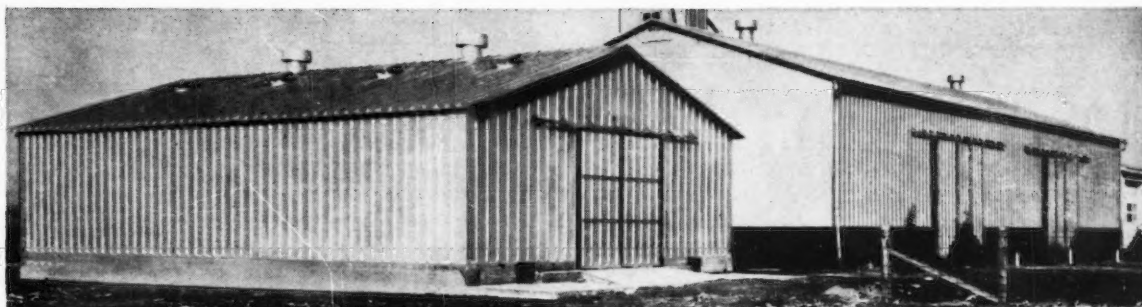
Break-Away recouples by merely backing tractor

Like pivot action, the Case Break-Away Safety Release is another advance toward faster, more efficient plowing. Stumps and stones that would damage fixed plows merely cause the Case Mounted Plow to uncouple from its fore-frame. Backing the tractor recouples it. A touch of the hydraulic control lifts it over the obstacle, and plowing proceeds.



- For education, information and training . . . the advantage of teaching visually everything from good plowing to pond building, strip cropping to water spreading and farm safety to seed saving . . . Case has clear, vivid materials. To see what may help you from sound-color movies to illustrated charts, send for the booklet that describes them all, "Visual Aids to Modern Farming." J. I. Case Co., Racine, Wis.





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says Wayne Ladd, Bunker Hill, Indiana

● Steel buildings have proved to be a practical, money-saving investment to this modern farmer. That's why he has three of them. "Steel buildings are the best," declares Mr. Ladd, "I bought my first one seven years ago, and have yet to spend a penny for maintenance on any of them."

The newest steel building was erected by two men in three days. "And it was inexpensive," says Mr. Ladd. "It cost about 15 percent less than a frame building of the same capacity. Keeps my crops in better condition, too, because it's weather-tight and rodent-proof."

In addition to low first cost, low erection cost, and no maintenance to date, Mr. Ladd mentioned another important savings item. "The fact that I can store so much in one place saves me about 100 man hours a year in moving equipment from one building to another."

Mr. Ladd highly values his 160 head of Aberdeen Angus cattle and 610 head of hogs. "The fact that steel buildings are fire-safe had a lot of influence on my purchase. I esti-



MR. LADD WITH HIS GRANDSONS, John and Robert Galbreath. Of his three steel buildings, Mr. Ladd uses one for combined soybean and implement storage, another for grain and the third for corn.

mate that fire, wind and tornado insurance on each building and its contents costs 35 percent less than with a frame building."

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UNITED STATES STEEL

AGRICULTURAL ENGINEERING

Established 1920

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SCORES 5 WAYS

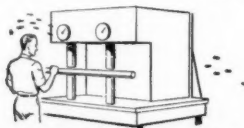
See why **LINK-BELT Augers**
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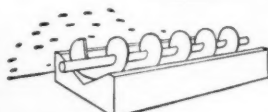
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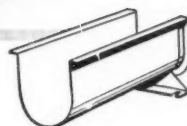
2 UNIFORM PITCH. Specialized modern machinery assures accurate forming, producing uniform flighting curvature.



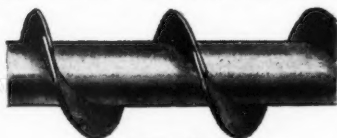
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Helicoid flight



Unmounted Helicoid flighting



Helicoid flight with end, plain beater

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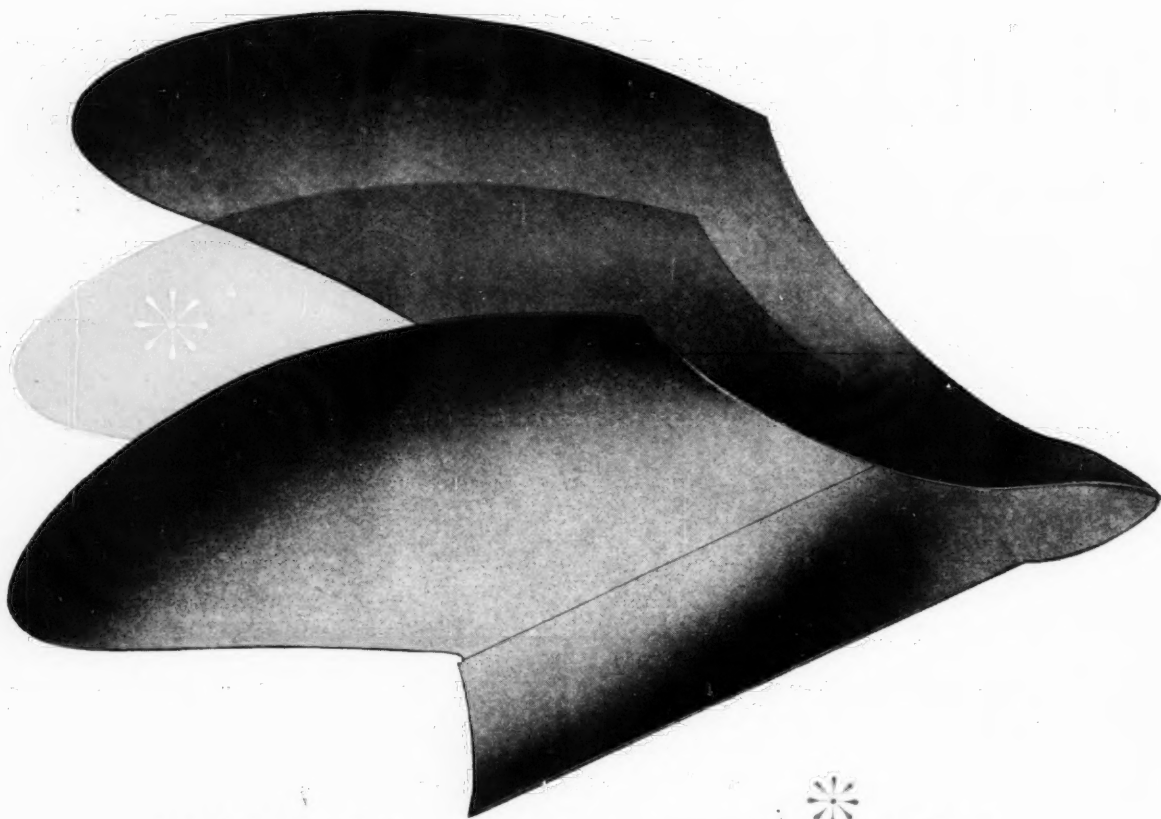
Opposed flights with center saw-tooth beater

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HYATT Barrel Bearings are ideal for a wide range of applications—at prices far lower than you'd expect. No wonder so many designers are so enthusiastic about the HYATT Barrel Bearing that *does so many jobs better*. If you have a bearing problem, this may be your answer. May we send you full details? Hyatt Bearings Division, General Motors Corp., Harrison, New Jersey.

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STRAIGHT

BARREL

TAPER

ROLLER BEARINGS

FROM CLEARING THE FIELD

Equipment Makers specify Dayton V-Belt Drives to get Top Performance

Cultivating, harvesting, preparing seed beds, baling, clearing grasslands — whatever the operation — equipment manufacturers specify Dayton V-Belt drives.

Extensive tests on many different applications have proved that Dayton V-Belts will out-perform and outlast

all others, regardless of how rugged the operation might be.

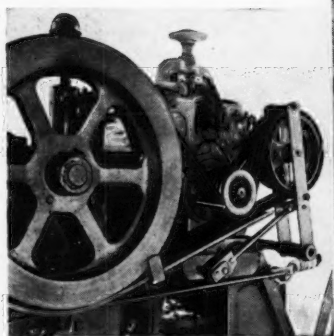
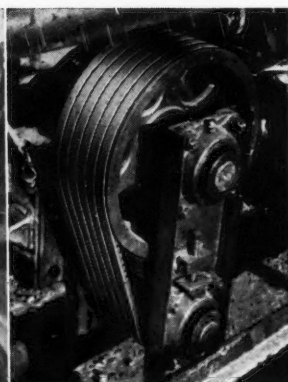
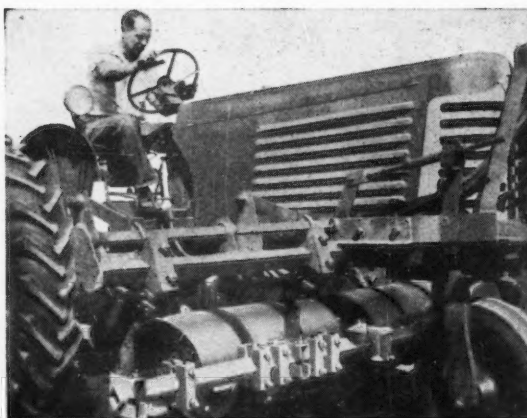
The following are typical examples of farm implement drives where Dayton Agricultural Engineers have worked with manufacturers and their designers in the laboratory and in the field to solve specific power transmission problems.



1. EFFICIENCY. Stepping up drive efficiency was a "must" in developing the Lilliston Implement Company Roto-Speed cutter for rugged grassland clearing. The answer — four raw edge Dayton V-Belts which produced maximum, continuous cutting power.

2. POWER. A space-saving V-drive that could transmit tremendous power was necessary in the development of the Robinson Blower & Engineering Corp., Bye-Hoe, 3 purpose cultivator.

Cultivating, preparing seed beds or blocking and thinning, this Dayton Cog-Belt* driven power take-off assembly assures constant trouble-free transmission.

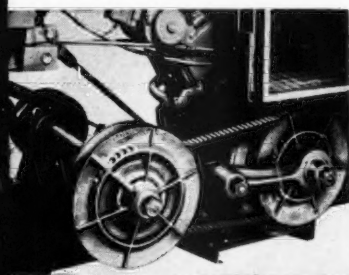


3. ECONOMY. One of the problems in the development of the New Holland Super "77" Baler was attaining economical high speed operation. The answer was two-fold. Four harder-gripping, stronger Dayton B-Section V-Belts on the main drive at left, give highest capacity, low cost baling by transmitting every ounce of power developed. The Dayton C-Section agricultural V-Belt on the Feeder Drive, designed to slip on overload, saves wear and costly replacement of metal parts.

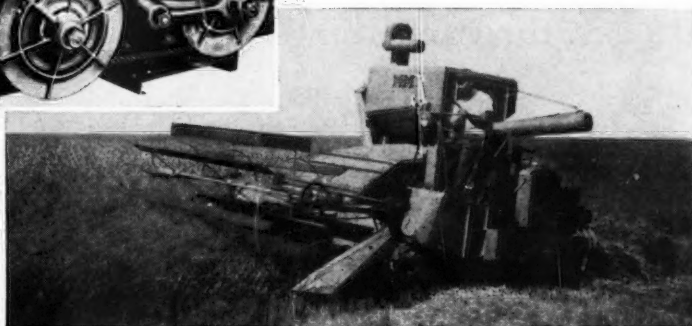
TO FINAL HARVEST...



4. ENDURANCE. For its No. 55 Combine, John Deere needed V-Belts that could "take it." The answer — Dayton Double Angle and Dayton Back Side Idler V-Belts, selected after three years of intensive testing. Test results established the ability of Dayton V-Belts to deliver power under the most adverse conditions of field operation.



5. VERSATILITY. Minneapolis-Moline, in the development of its Uni-Farmor Harvester, needed a Vari-speed drive belt that could supply power to several different attachments. Dayton Double-Cogs outperformed all other belts in extensive tests.



Dayton offers complete engineering service to assist you with your V-Drive problems

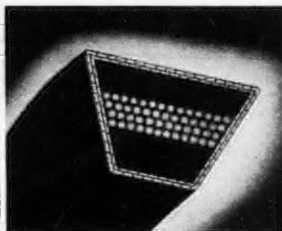
Whether assistance is needed in standard application or in special design, Dayton's staff of agricultural experts stands ready to work out the details with you, from drawing board to final test under field conditions.

Dayton Sales Engineers bring to every V-drive problem the skill and practical knowledge that can only be gained through working experience in every agricultural operation. Moreover, they have the advantage of the latest in technical information and the understanding of its application. Every problem, large or small, receives their prompt consideration and wholehearted cooperation.

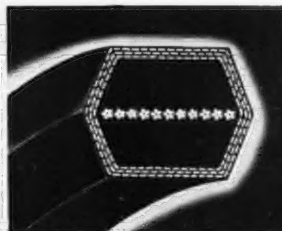
When difficulties arise in developing new V-drive equipment or in improving present power transmission systems, remember the entire facilities of the Dayton Agricultural Division are at your disposal. Write direct to Dayton Rubber Company, Agricultural Original Equipment Division, Dept. 40, 1500 S. Western Avenue, Chicago, Illinois.



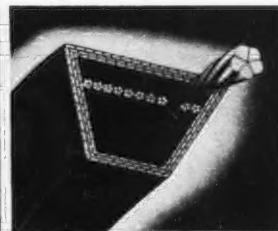
Double Cog-Belt
Cross Section



Back Side Idler V-Belt
Cross Section



Double Angle V-Belt
Cross Section



Agricultural V-Belt
Cross Section

Dayton Rubber

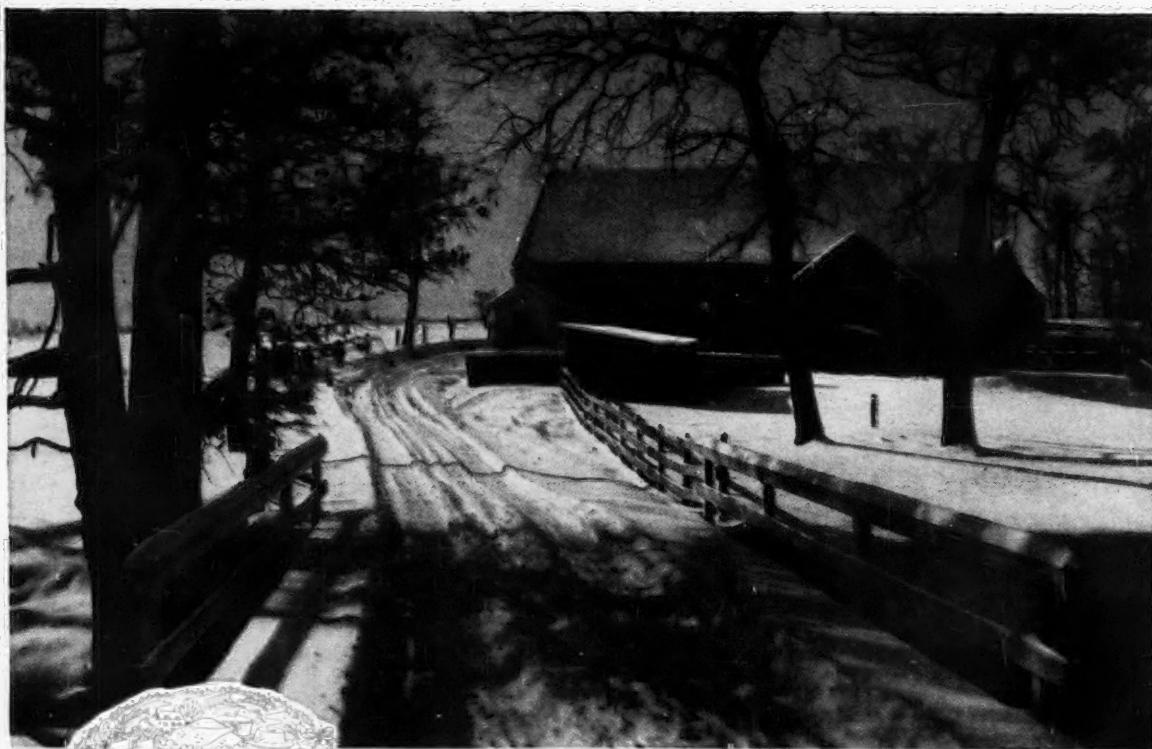
*T.M.

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It's a winter's night, and an angel song . . . a giant star, and a tiny stable . . . a manger, and straw, and swaddling clothes.

Christmas is a chime . . . a boy soprano, and *Silent Night* . . . carolers, and *The First Noel* . . . the tinkle of a bell on a sleigh, of a coin in a cup.

Christmas is Dickens, and Scrooge, and Tiny Tim. It's holly on the door, a candle in the window . . . the scent of pine, and the sparkle of tinsel.

Christmas is red and green, and blue and silver. Christmas is white.

Christmas is cards, and ribbon, and tissue paper. It's a trip home, an open latch, and a handclasp. It's giblets, and biscuits . . . cranberries, and mince-meat pie.

Christmas is cold and warmth . . . forgiveness, and a smile.

Christmas is a prayer . . . a renewed plea for an ancient hope . . . *For Peace on Earth, Good Will Toward Men.*

Copr. John Deere, Moline, Ill.

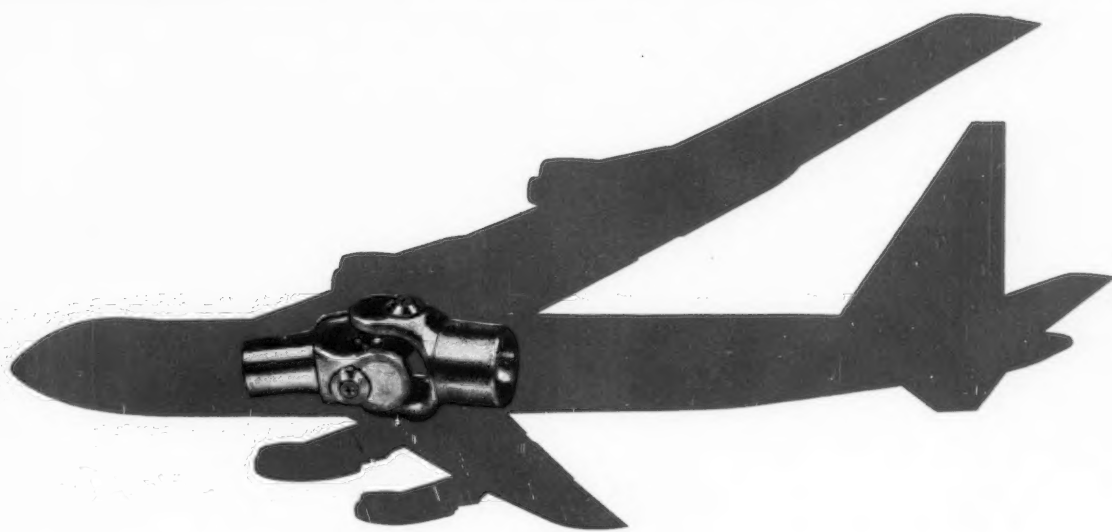
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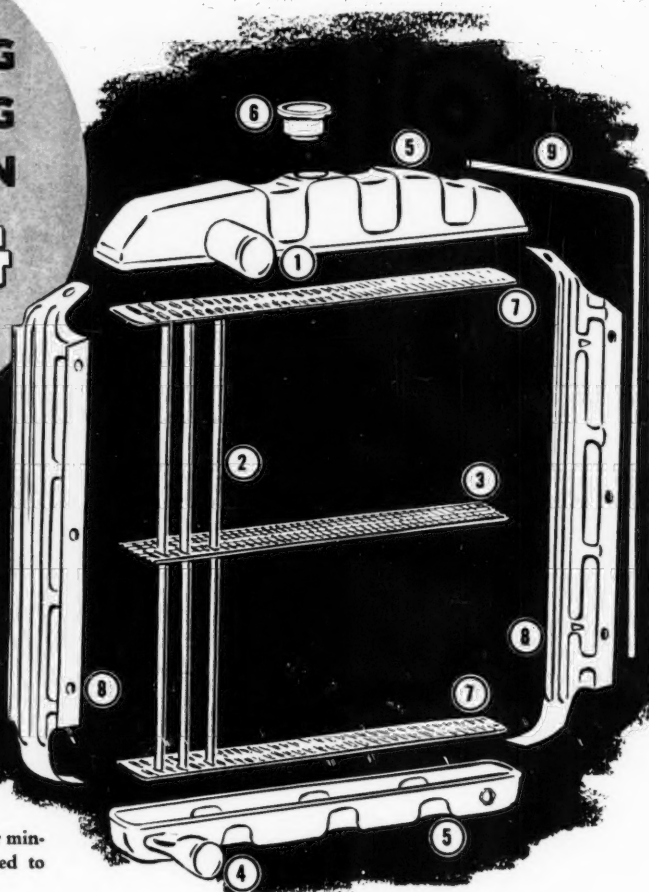
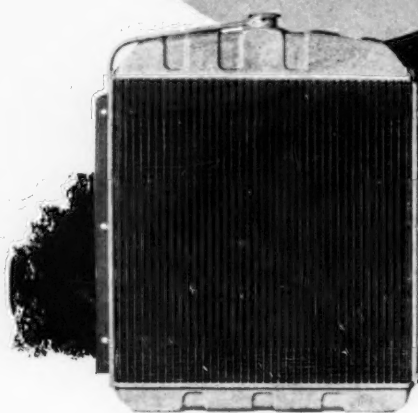
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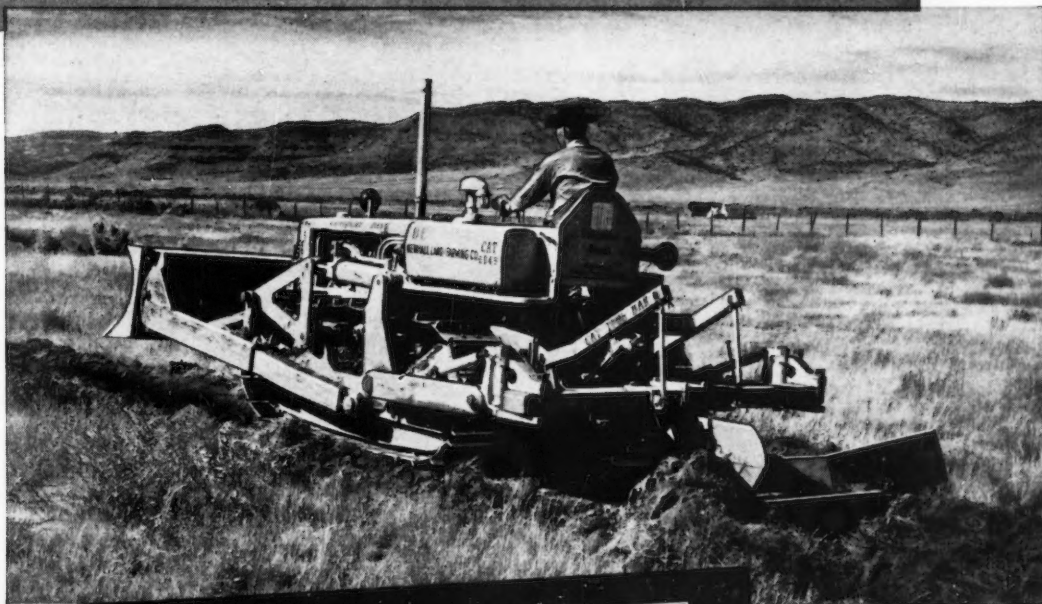
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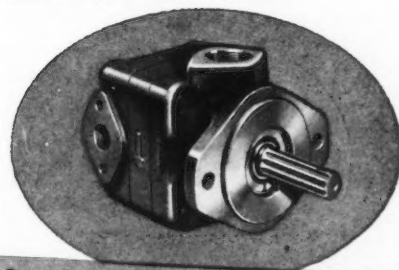
"Caterpillar" No. 41 Hydraulic Control imparts increased versatility to "Caterpillar" D2 and D4 Diesel Tractors. Here a D4 Tractor and tool bar with ditcher attachment is making irrigation ditches.



"CATERPILLAR" uses **VICKERS** HYDRAULIC PUMPS

"Caterpillar" selected the Vickers Pump (shown below) for the source of power in the No. 41 Hydraulic Control because of its outstanding performance . . . performance that results from several exclusive features. This Vickers Pump is vane type, hydraulically balanced and has automatic wear compensation. This means that it delivers more oil while taking less power from the engine . . . that it has a much longer life with minimum maintenance . . . and that it insures dependability and easier cold weather starting of the tractor. A Vickers Pump is the mark of high quality in hydraulic power controls.

This is the Vickers Pump used in the "Caterpillar" No. 41 Hydraulic Control. Hydraulic systems on tractors and other farm equipment use more Vickers Pumps than any other make.



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Here's the New Holland Super "77" Automatic Baler at work. Cut-away at right shows construction of BCA Cam Follower Bearings on this equipment.



BCA

CAM FOLLOWER BEARING ASSEMBLIES

**reduce installation and service problems
on New Holland Super "77" Automatic Balers**

BCA Cam Follower Bearings are low-cost package units. They combine a pre-lubricated bearing and a mounting stud in a single assembly specifically designed for agricultural use.

On its Super "77" Automatic Balers, New Holland Machine Company uses fifteen BCA Cam Follower Bearings. One is used as a cam follower on the upper knottor cam gear; and fourteen are used on the pick-up finger assembly. In addition to low initial cost, these bearings give New Holland the advantage of substantial savings on installation time.

BCA Cam Follower Bearings stand up to the terrific punishment of agricultural service. And, because the pre-lubricated bearing is effectively sealed against dust and grit, the farmer has no field-servicing problems.

BCA engineering cooperation and design assistance helps solve problems involving ball bearings—the BCA Cam Follower Bearing is a typical result. It will be to your advantage to bring your bearing problems to us.



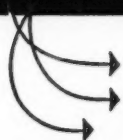
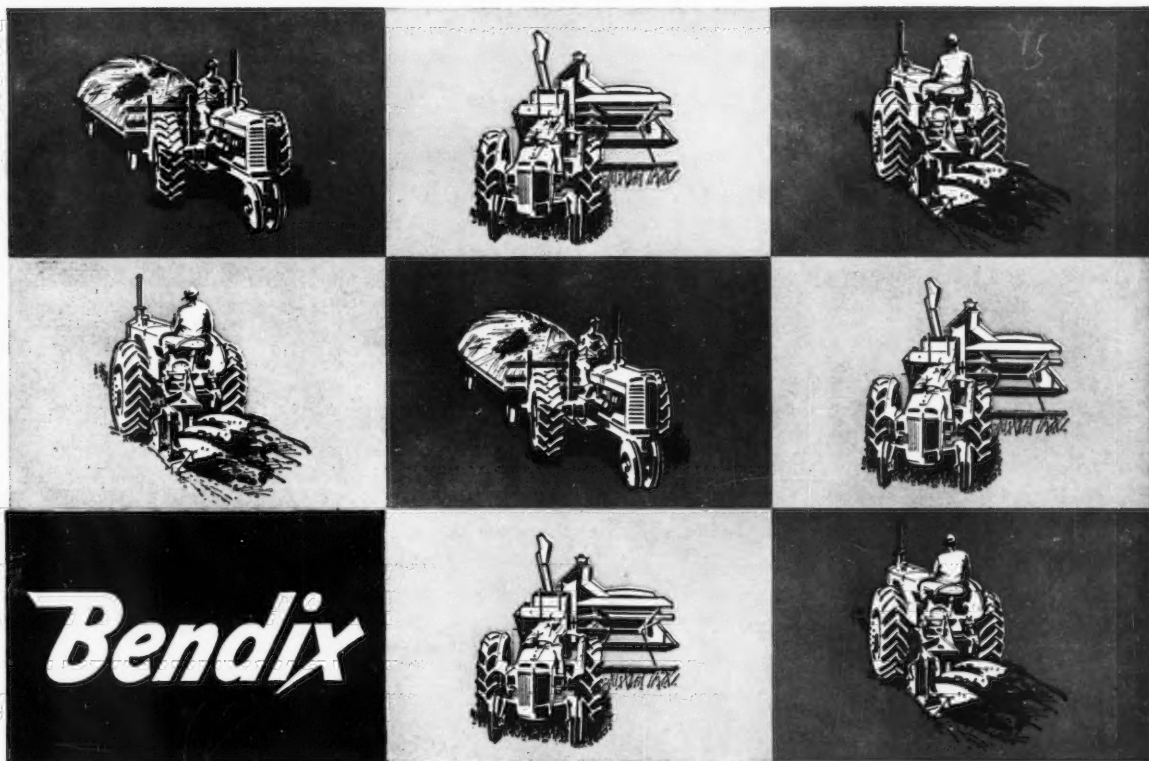
BEARINGS COMPANY OF AMERICA

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LANCASTER • PENNSYLVANIA

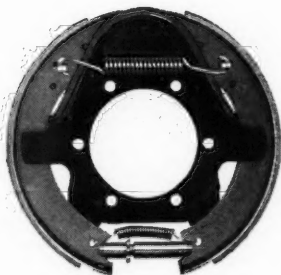
Pioneers of pre-lubricated package unit ball bearings for agriculture





Farm Tractor Brakes...

backed by the greatest name in braking



The Bendix heavy-duty farm tractor brake has powerful and positive holding action in both forward and reverse. Rugged design assures uniform performance day after day, under the most severe field and road work.

For 25 years Bendix has specialized in building brakes for the automotive industry. In that period of time the Bendix Products Division at South Bend has built more than 90 million brakes for passenger cars, trucks and farm tractors.

These are reasons why tractor manufacturers—as well as passenger car and truck manufacturers—look to Bendix as brake headquarters.

Bendix Brakes for farm tractors are specifically designed for the exacting needs of this class of service, combining rugged, dependable and smooth action with low cost. That's why Bendix Brakes are the logical choice for the modern tractor.

Let Bendix farm tractor brake engineers help you solve your brake problems. Write for detailed information.*

*REG. U.S. PAT. OFF.

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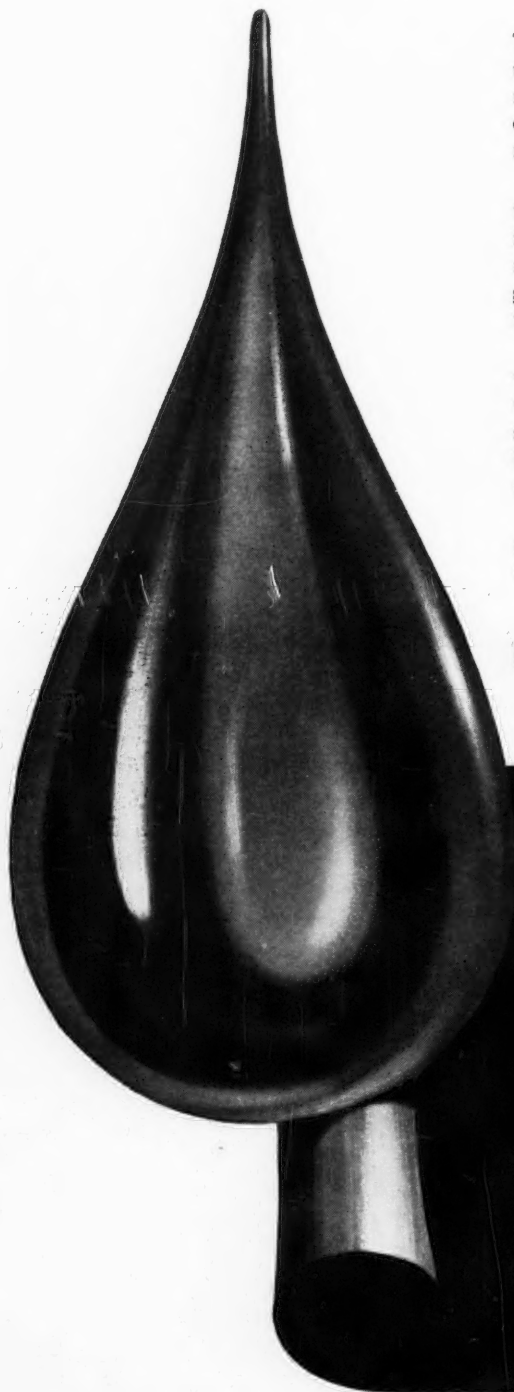
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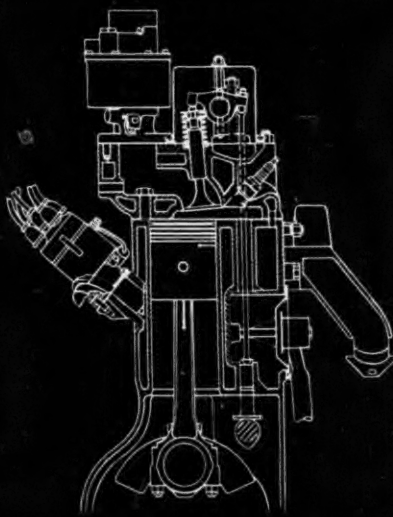
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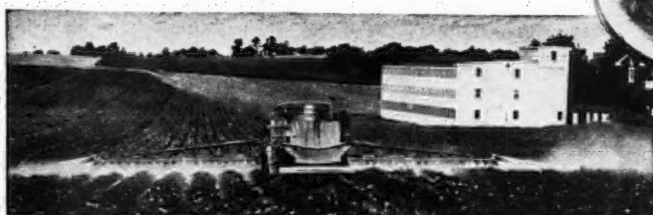
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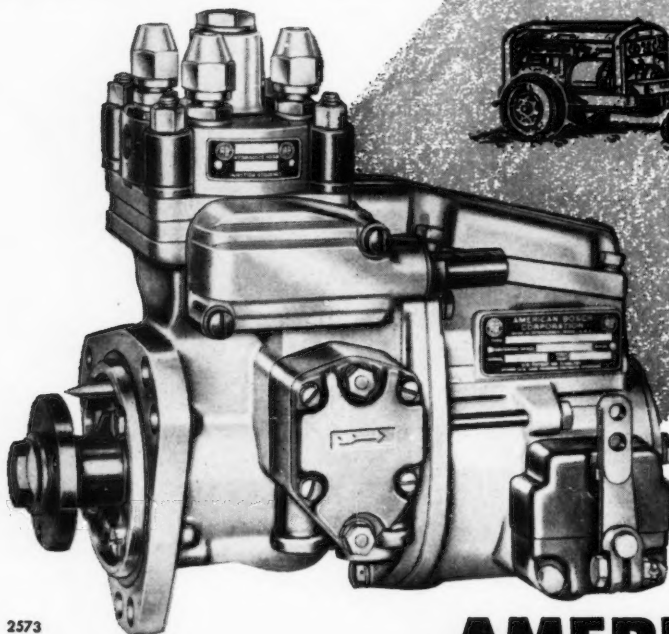
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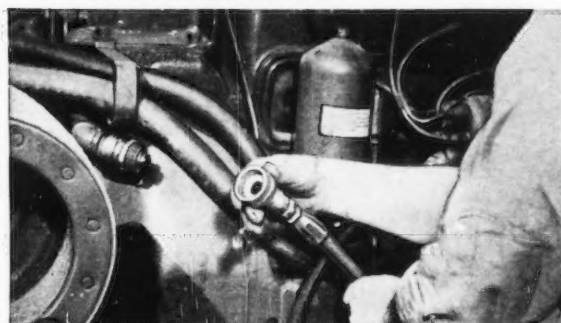
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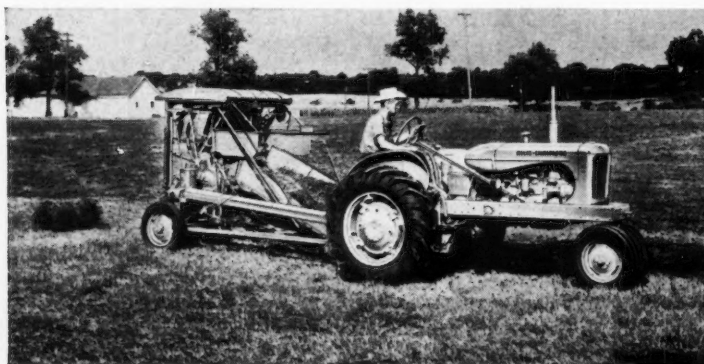
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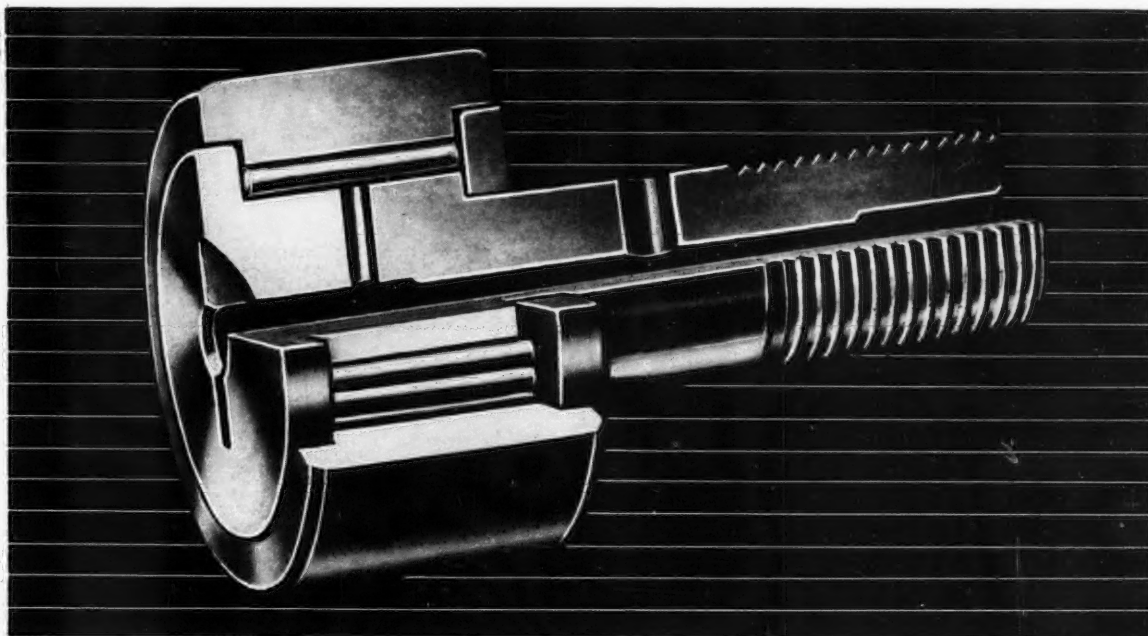
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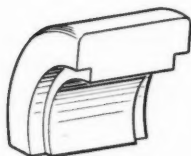
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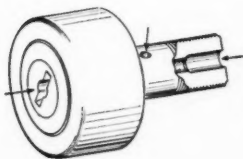
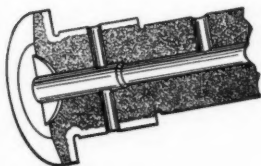
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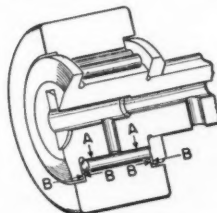
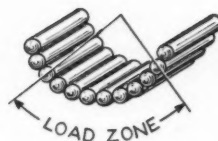
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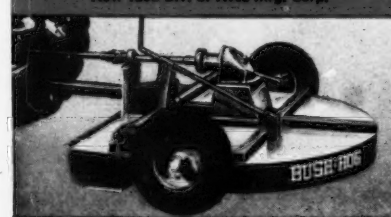
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AGRICULTURAL ENGINEERING

VOL. 35

DECEMBER, 1954

NO. 12

Effects of Improper Inflation Pressures on Farm Tractor Tires

*Rubber Industry Engineers Stress the Importance of
Correct Inflation to Insure Maximum Service Life*

Progress in Tractor Tire Development

P. J. Forrest

THERE may be conflicting opinions about the first application of pneumatic tires to a farm tractor, but they were first introduced commercially in 1932. Thus in the short span of 22 years farm tractor tires have been developed to the point where they represent a real contribution to farming and the national economy. The reason this has been possible is because farm tires had something definite to offer in the way of performance, saving of time, fuel and maintenance, and giving greater comfort to the operator.

Early in the development and commercial application of farm tractor tires it became evident that many sizes of varying cross-sectional width and over-all diameter would be required. A range of sizes was necessary for the many tractor models to transmit the power of the engine, provide the necessary traction and match the diameter of the steel wheels which they replaced. Somewhat later the need for an orderly program was recognized and the pneumatic tire industry established standards for tire cross section, rim diameter and width, loads and inflation pressures.

The comparatively low inflation pressures of 10 to 20 psi established for farm tractor tires required a rim mounting that would prevent tire slippage. Drop-center rims had already been developed for passenger car tires for ease of mounting and this approach was used in the design of rims for tractor tires. The rim was provided with a tapered-bead seat and tire beads were made to a corresponding taper for a tight fit. Rim standards were ultimately adopted in two widths, 6 and 8 in; later the 5½-in width was added to accommodate tires of smaller section.

Except for the use of fewer plies, the construction of the first tires developed for farm tractors followed more or less conventional tire engineering practice. The cross section and tread were quite round and the ratio of rim width to cross section varied from 55 to 75 percent.

Tires were available in two typical tread patterns—a rather closely spaced nob or button type of non-directional design and a more generously spaced lug or bar type of directional design. Both types were of comparatively shallow anti-skid or lug height, that of the 11.25-24, for example, being only about ½ in.

Symposium of four papers presented at the annual meeting of the American Society of Agricultural Engineers at Minneapolis, Minn., June, 1954, on a program arranged by the Power and Machinery Division.

The author—P. J. FORREST—is assistant manager, tire design, United States Rubber Company.

Two major problems existed in tires of early design, namely, limited ability to provide adequate tractive effort in a variety of soil types and relatively poor cleaning ability in heavy soils. To improve these properties the first major change in tread design was made in 1936. The principal design revisions made at this time were increased lug height with greater lug spacing and wider, flatter treads. These changes provided performance improvements that furthered the acceptance of the farm tractor tire.

For the most part, tractors of this period were large, heavy machines designed for use on steel wheels to which tires were fitted as special equipment. The low-pressure tractor tire with its many advantages made possible the design of smaller, lighter weight, faster moving tractors. Tractor manufacturers next designed and developed smaller one and two-row-crop models using tires of large diameter and smaller cross section which became very popular.

As tires of larger cross section were introduced for tractors of greater horsepower, it became evident that the ratio of rim width to tire cross section was out of balance. The 8-in rim, for example, was too narrow for a 13.50 tire. This led to the next important change in farm tractor tires—the development of new standards to provide a series of rim widths more in keeping with tire sizes. Tire and rim combinations were designed to provide an 84 percent ratio of rim width to tire cross section. To maintain this ratio, each cross-sectional size required a specific width of rim. This program was introduced in 1938 and was made possible through the combined efforts of the tractor and tire industries.

The profile or shape of the tread of the new tires was again made flatter and much wider than the older type. From shoulder to shoulder the tread was approximately 100 percent of the tire section width. The current method of size marking tractor tires was adopted at this time to differentiate the new type from the old.

The principal advantages claimed for the new design tire and rim combination were:

- Easier tire mounting and dismounting because the new rim had lower flanges, deeper and wider wells, and narrower bead ledges.
- Greater width between the tire beads straightened sidewalls providing more stability with less sidesway.
- Greater load-carrying capacity due to the increased contained air volume. This also permitted an increase in liquid ballast for heavy work.

Prior to the adoption of these new standards, tires were available in 3 section widths and 5 rim diameters. At the

present time 11 section widths and 8 rim diameters permit flexibility in applying the correct tire and vehicle to any particular job.

Shortly after World War II further design changes led to the present commercially available types. The lug height was increased and treads were made still flatter and slightly wider to provide greater traction and longer wear. At this time the tire industry adopted standards limiting the height of lug of the various tire sizes.

While the standard type tractor tire is adaptable to a wide range of soil conditions, there are areas in this country, notably Florida and other sections of predominantly light sandy soil, where the flotation requirements demand a special type of tire. Self-propelled harvesters, rice and cane-field equipment also require special types of tractor tires to meet specific operating problems. The tire industry has developed tractor-type tires to satisfy this variety of special-purpose applications. As the tractor and implement industry continue to design and develop highly specialized types of farm machinery, special types of tires will be made available.

Since the commercial introduction of the farm tractor tire, maintenance of proper inflation pressure has been a continuing problem to the tire industry. The manufacturer is in the position of recommending inflation pressures that provide the best balance of tire performance and durability, but the control of this factor is the responsibility of the operator.

The use of 12 psi inflation pressure has become accepted, more or less, as the standard for rear tractor tires, regardless of the job the tractor is to perform, the load on the tires or the speed of operation. It should also be pointed out that this is a *minimum* inflation pressure at an established load value.

Problems of Tractor Tire Application

J. M. Hooper

Member ASAE

FARM tractors today have many more diversified uses than during the period when farm service pneumatic tires were first introduced. Various attachments, which are continually being developed, have resulted in tractors being progressively used more hours each year. Tractors now have more available pulling power thus allowing work to be accomplished at a faster rate of speed. Tractor efficiency, maximum drawbar pull, weight, and speed in plow gear have all steadily increased since the 'thirties. All of these strides in tractor design enable the farmer to accomplish more work faster than ever before, which means that much more work is being transmitted through tractor tires. Thus proper care of tires has become an increasingly important factor in obtaining the long service life expected.

Underinflation accounts for many rear tractor tires giving less than normal life expectancy. This means that most premature carcass failures are the direct result of tires being operated in an over-deflected and sometimes buckled condition. Since this problem of underinflation is very important to the life of rear tractor tires and can be corrected only by the tractor operator, it is necessary that it be fully explained by both tire and tractor manufacturers.

In analyzing and comparing specification data of the various types of tractors manufactured from 1940 to 1950,

and those manufactured after 1950, we found that, on the average, more than two pounds additional inflation pressure is necessary for standard rear tires on tractor models manufactured after 1950. This increased pressure compensates for the higher tire loads needed to utilize the power of later model tractors.

Our field checks show that many tractors are being operated with rear tires underinflated from two to four pounds. A reduction of two to four pounds in air pressure may seem small until it is analyzed in terms of load-carrying capacities of these tires. A small decrease in the inflation pressure of rear tractor tires, which operate at relatively low pressures, represents a large percentage drop, when compared with tires which normally operate at higher pressures. Likewise, the load capacity, which is dependent upon the air pressure, is considerably reduced. For example, a rear tractor tire will lose 18 percent load-carrying capacity, when permitted to drop from 14 to 10 lb pressure, while a tire that operates at 70 lb pressure will lose only 3½ percent load-carrying ability with a drop of 4 lb in pressure.

Sidewall distortions of 12×38 6-ply tires were observed and carefully measured under various loads, as the pressure was reduced from 20 to 8 lb. The following occurred:

- Strains on the tires became critical with a few pounds drop from the recommended pressure.
- Unit-load intensities across the loaded tread area changed as the air pressures were changed under constant loads. As the pressure was reduced, the load intensity in the tread center was decreased and was built up rapidly in the shoulder areas.
- Increased concentration of load in the tread shoulders at low inflation pressures caused severe bulging of the sidewalls and finally caused acute buckles. A tire operating in a buckled condition is doomed to early failure.

The trend in tractor tire design has been to make the tread flatter and the cleats higher at the shoulder. This is also a trend which makes these tires more vulnerable to failure when operated at low pressures.

Another problem with tractor tires is in connection with the high inflation pressures used to reduce the bouncing of tractors during shipment. Front tractor tires are permitted to be inflated to the maximum shown in TRA (Tire and Rim Assn.) tables, which is up to 44 lb for some tires. Rear tires of 4-ply rating and above may be inflated up to 30 lb. These high pressures increase the cord stress, making the tires more susceptible to bruising. It is, therefore, important that these pressures be reduced to operating pressures before tractors are unloaded from their carriers.

Overinflation of front tractor tires in service has been the cause of premature bruise failures in many cases. It is found that some tractor operators overinflate these tires when front-end loaders are used. Recently we found almost 50 lb pressure in two experimental front tires that were placed on a farmer's tractor with 28 lb pressure. This farmer explained that a little air was added because he had been using a front-end loader. It is important for the operator to know that, when mounted implements are used, at speeds not exceeding 10 mph, rated loads on front tires may be increased up to 35 percent with no increase of rated inflation.

Tire problems in connection with the modern tractor may be summarized as follows:

- More work is being transmitted through tractor tires due to the increase in the engine power of current tractors.
- An increase in rear tire loads is necessary to utilize the greater pulling power of present-day tractors. This results in higher air-pressure requirements of rear tires. The common use of 12 lb pressure is certainly not adequate to support the tire loads of all tractors.
- Underinflation accounts for many premature failures of rear tires. Strains in rear tires become extremely critical with a few pounds drop from recommended pressures.
- High pressure in tires increases the cord stress. Hence, over-inflated tires are more susceptible to bruising.

It is necessary that the importance of maintaining proper inflation pressures be stressed to tire dealers, tractor dealers, and to individual tractor operators.

Effects of Inflation Pressure on Traction and Tread Wear of Tractor Tires

Ralph W. Sohl

Member ASAE

REAR tractor tire sizes have usually been selected with tire load ratings, at 12-lb inflation, equal to or greater than the static weight on the tractor rear axle. This then permits the inflation pressure to be increased, when load is added in the form of wheel weights, liquid ballast or attached implements, in order to maintain normal deflection of the tire. Too often, however, the 12-lb inflation figure has been taken to be a universal recommendation without regard to tire size or loading. The result is that tires are most frequently operated much underinflated, thereby causing premature fatigue failures.

Traction

Over the past years a considerable amount of testing has been done to determine how inflation pressure affects traction. I will refer to data from four such tests, reports of which were available in the preparation of this paper.

TABLE 1. DRAWBAR PULL AT 16 PERCENT TRAVEL REDUCTION

Tire size	Test Track				English Farm				Hoffman Farm			
	Rear load, 2550 lb				Rear load, 2936 lb				Rear load, 2936 lb			
	8 lb	16 lb	lb dif.	% dif.	8 lb	16 lb	lb dif.	% dif.	8 lb	16 lb	lb dif.	% dif.
9.00-24	1420	1490	-70	-4.7	985	870	+115	+13.1	1275	1050	+225	+21.4
11.25-24	1390	1490	-100	-6.7	1100	1000	+100	+10.0	1360	1060	+300	+28.3
12.75-24	1365	1440	-75	-5.2	990	870	+120	+13.8	1350	1085	+265	+24.4
13.50-24	1410	1550	-140	-9.0	1220	1020	+200	+19.6	1260	1010	+250	+24.8
9.00-36	1485	1650	-165	-10.0	1130	960	+170	+17.7	1360	1060	+300	+28.3
Average percent difference	-7.1				+14.8				+25.4			

The first (Table 1) reports tests made at the University of Nebraska by Samuelson, Hurlbut and Smith, and includes work done on two farms and the Nebraska Test Track, with five sizes of tires at two inflation pressures. As Table 1 shows, low pressure improved performance in the farm tests which were on plowed ground but gave poorer performance on the test track.

It should be noted, at this point, that for the test-track load condition only the 9.00-24 size tire is carrying its rated

The author—RALPH W. SOHL—is manager, tractor and implement tire development, The Goodyear Tire & Rubber Co.

capacity even at the 8-lb inflation pressure, and other sizes are underloaded from 13 to 83 percent. For the field tests at 8-lb inflation, the 9.00-24 tire is 6 percent overloaded, the 9.00-36 tire is 2 percent overloaded, while the three larger sizes are underloaded from 7 to 60 percent.

All tires are, of course, underloaded at the higher inflation pressures and consequently have less than normal deflection and contact areas.

The figures in Table 2 are taken from the Society of Automotive Engineers Cooperative tests completed in 1937

TABLE 2. VARIATION OF TRACTION COEFFICIENTS WITH INFLATION PRESSURE

Soil condition	Percent travel reduction	Average traction coefficient		
		8 lb	12 lb	16 lb
Concrete Road	5	.71	.66	.61
Dry Clay	16	.56	.55	.53
Sandy Loam	16	.53	.50	.49
Dry Fine Sand	16	.39	.36	.33
Gravel Road	5	.35	.37	.37
Green Alfalfa	8	.39	.36	.35

showing traction coefficients for various soil conditions. These coefficients are the drawbar pull divided by the true rear-axle load, which is the static load plus weight transfer due to pull.

It will be noted from Table 2 that the lower inflation gave improved performance on all but the gravel-road condition.

It should be pointed out that at the minimum test load for the tractor, five of the eleven tire sizes tested were overloaded at the 8-lb inflation pressure ranging from 7 to 53 percent.

TABLE 3. 10-38 TIRE AT 16 PERCENT SLIP

	Rating 1760 lb at 12 lb inflation (1340 lb at 8 lb)					
	Hard clay loam			Loose clay loam		
Inflation	8 lb	12 lb	16 lb	8 lb	12 lb	16 lb
Load	1285	1285	1285	1285	1285	1285
Pull	1865	1575	1520	1080	950	845
Load	1700	1700	1700	1700	1700	1700
Pull	2340	2265	2245	1730	1530	1120
Increase, lb	485	690	725	650	680	275
Increase, %	26.2	43.8	47.6	60.2	71.5	37.6

At 8 lb inflation and 1700 lb load the tire is overloaded 27%.

Work done at Michigan State College by Suave and McKibben in 1944 gives the results shown in (Tables 3 and 4) in connection with tests of tires with varying percentages of liquid filling.

TABLE 4

Tire size	Hard Clay Loam				Loose Clay Loam			
	12-26	12-26	10-28	10-28	12-26	12-26	10-28	10-28
Load per tire	1225	1225	1110	1110	1225	1225	1110	1110
Inflation	6 lb	12 lb	9 lb	12 lb	6 lb	12 lb	9 lb	12 lb
Pull at 16% Slip, lb	1705	1640	1380	1325	1020	970	765	805
Difference, %	+4		+4.1		+4.9		-7.9	

These tires have ratings above the loads even at lowest pressures.

In the wide-rim tests made at the USDA Tillage Machinery Laboratory of the U.S. Department of Agriculture at Auburn, Ala., in 1951, reported by McKibben, Reed and Reaves, the 14-26 tire size was used in one group of tests at a load of 3120 lb per tire with 8-lb inflation pressure.

This was reported to give a 15 percent increase in drawbar pull and improved work efficiency (Table 5). This is a 27 percent overload on the tire and would definitely reduce tire life because of excessive distortion and wrinkling.

TABLE 5. 14-26 R3 TIRE AT 15 PERCENT TRAVEL REDUCTION

Rim width, in	Torque input, lb ft		Drawbar pull, lb		Tractive efficiency, %		Coefficient of traction, %
	12	18	12	18	12	18	
8 lb at 3120*	3713	3631	1338	1318	62.5	62.9	39.2
8 lb at 2460	3036	3005	1019	1029	58.5	59.4	30.8
12 lb at 3120	3459	3463	1151	1186	59.2	60.3	34.3

* This is a 27% overload on tires and will result in premature flex failures.

Tread Wear

Low inflation pressure produces uneven, irregular tread wear in road service. This is caused by excessive scrubbing and wiping of the tread as it contacts and leaves the road. Typical examples of this are shown in Fig. 1.

High inflation pressure concentrates wear in the center of the tread as the tire has less than normal deflection and



Fig. 1 (Left) Typical examples of uneven, irregular tread wear in road service produced by low inflation pressure • Fig. 2 (Right) An example of how high inflation pressure concentrates tire wear in the center of the tread

only the center portion of the tread contacts the ground. Fig. 2 shows this type of wear.

Conclusions

Low inflation pressures appear advantageous for traction, particularly in loose types of soil, but this advantage is relatively small until substantial overloads are reached which will definitely shorten tire life.

Low inflation pressures also accelerate rapid and uneven wear on highways.

It will pay the tractor owner to give more attention to maintaining proper inflation pressure in his tires in order to insure satisfactory performance and normal life.

Effect of Inflation Pressure on Rear Tractor Tire Life

George F. Mullin

THE one factor having the greatest effect on the service life of a tractor tire is its inflation pressure. Underinflation or overinflation each result in a particular type of premature failure, while correct inflation will permit the tire to deliver its maximum life free of trouble to the operator. There are many factors that have developed during the past few years that make the use of correct inflation even more important today than in the early years of the application of tires to the farm tractor.

In the development of the modern farm tractor, the horsepower has steadily increased with the introduction of new models. The over-all average increase is about 3 percent per year (Fig. 1). Thus a tractor that would develop

30 hp in 1944 will, in today's model, develop 40 hp. Some models have increased their horsepower output as much as 50 percent during this period. The increase in power in farm tractors has made it possible to pull greater drawbar loads. Larger plows, more plow bottoms, bigger and heavier field tools are in use today. In order to provide adequate tractive effort in utilizing this additional power, many farmers use more added weight than was generally the practice ten years ago. This is commonly applied by use of cast wheel weights or liquid filling of the tires. Many operators use both.

Minimum recommended pressure is generally sufficient for rear tractor tires operated without additional weight or mounted implements. When weights are added, the additional pressure required should be determined; rule of thumb is to add 2 lb. With both wheel weights and hydroflation the maximum pressure is usually required.

There are changes taking place in the use of farm equipment. Two tractors coupled together are a common sight in some large farming areas. The claim is made that tractors coupled in this manner will pull nearly as much as three single units. This means four tires are doing the work six tires were expected to do. Field conversion of tractor engines, designed to increase the power output, is popular in certain communities. These and similar practices all result in additional stress and strain on the tractor tires.

A few years ago the tread bar heights were increased approximately 25 percent. This of course resulted in longer tire life and many more hours of service on the tire body and sidewalls.

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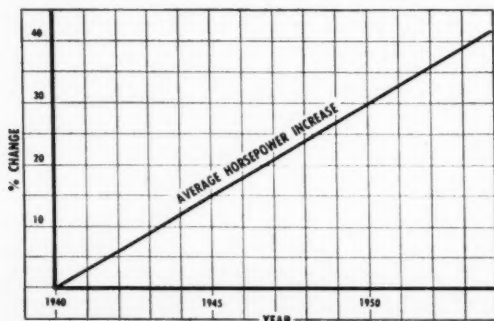


Fig. 1 Increasing trend of farm tractor horsepower

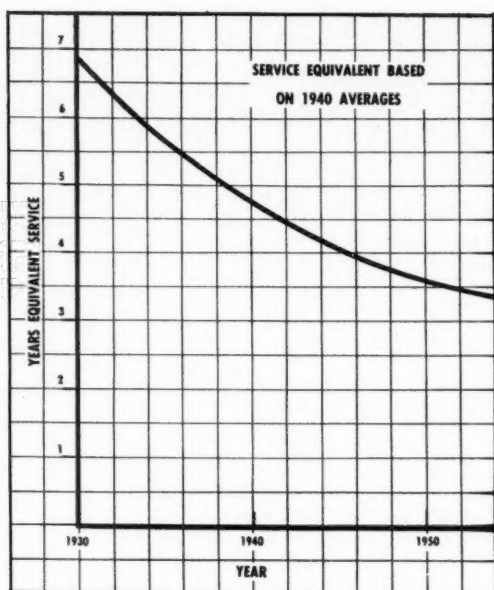


Fig. 2 Effect of increased use of tractor on life expectancy of tires

The average use per year of the farm tractor steadily rose from less than 400 hr in 1930 to 500 hr in 1940, and today is approaching the 700-hr mark. These are country-wide averages. Some operators will reach 2,000 hr per year. Based on the 1940 life expectancy, this means the tractor and its tires are now doing in three years the same work formerly accomplished in five years (Fig. 2).

In this paper the effect of underinflation versus correct inflation will be discussed, since by far the most common abuse is underinflation, which causes rapid tread wear and early fatigue failures of the cord body and sidewall rubber. Probably the most common and certainly the most expensive of these premature failures is the radial crack. It constitutes the predominating premature failure in the tires of larger cross section.

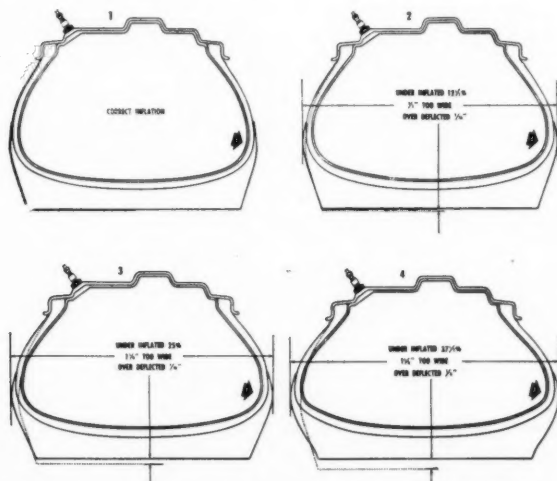


Fig. 4 These four profiles show the deflection and shape of a tractor tire section under a fixed load at different inflation pressures



Fig. 3 Arrows indicate radial cracks developing in a tire sidewall which results in the main from underinflation

Many times the farmer, the implement dealer, and the tire dealer look upon these failures as defective tires. But let us consider a radial crack failure. What is it? How does it develop? What is known about it? What can be done about it?

Radial cracks develop in the sidewall area of the tire. The rubber splits in a radial direction, usually appearing first as a small crack, or check, in the surface of the stock (Fig. 3). Frequently, in the early stages of the failure, there are several of these small checks in a confined area. As the failure progresses these checks may join, forming one large crack which will continue to grow, eventually working through the cord body of the tire and finally causing failure of the inner tube. This condition attacks all makes and types of tires when they are subjected to undue stress.

There are several contributing causes of radial cracks. First of all, a radial crack is a fatigue failure resulting from the sidewall rubber being repeatedly placed in excessive tension and compression. Underinflation (low pressure) is the one major factor contributing to these failures. To show why underinflation is such a factor in the destruction of the tire, we have made many tests and measurements.

Fig. 4 shows the deflection and shape of a section of tractor tire under a fixed load at different inflation pressures. Profile 1 is the shape of a properly inflated tire having the recommended inflation for the load it must support. Profile 2 is of a tire underinflated 12½ percent, profile 3 shows underinflation of 25 percent, and profile 4 represents an underinflation of 37½ percent.

Increase in the curvature of the inner tire body shape, when the pressure is lowered, is indicated by the arrows in Fig. 4.

The change in the sidewall shape and tire deflection may be noted by comparing the dotted line of the properly inflated tire with the contours of the underinflated tires. In measuring the change in length of the sidewall stock in a circumferential direction, we find the stretch increases over that of a normally inflated tire by 22 percent for a tire 25 percent underinflated, and 33 percent for the tire suffering from 37½ percent underinflation.

Do you believe farmers do not underinflate their tractor tires by 25 percent and more? A recent survey of a large number of tractors throughout the Great Plains states revealed that more than half, or 64 percent, were underinflated an average of 25.6 percent. These tractors were loaded with wheel weights and liquid filled tires to the point that 14.1-lb pressure was the average required inflation. Our measurement of the tire inflation pressure in these units averaged 10½ lb. They were 3.6 lb low, or 25.6 percent underinflated.

It is difficult to see the strains placed on a tire by watching it working on a tractor in the field, but in our company

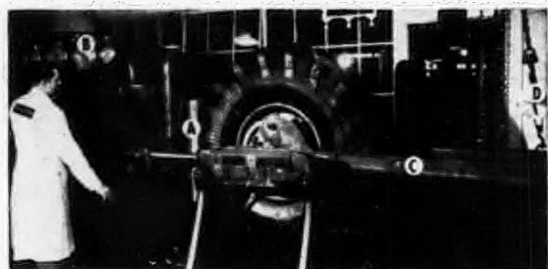


Fig. 5 Laboratory setup for applying load and torque to tires equivalent to that encountered in field operation

laboratory we have a test machine and equipment by means of which we can apply the same forces to the tire that it is subjected to on the tractor. On this test machine shown in Fig. 5, the vertical platform *A* is pressed against the tire until the desired load is obtained. This load is registered on a gage at *B* and corresponds to the weight of the tractor pressing against the ground.

A tractor pulling a load applies still another large force to the drive tires. In order to propel the unit forward, the tire must transmit the torque force applied at the axle. In our test setup this force is applied by the arms *C* and is measured on the dynamometer at *D*. For the purpose of our test, we have set up the pulled load as being one-half the load applied on the tire. This, then, represents a tractive coefficient of 50 percent, which is easily within the normal working range of farm tractors.



Fig. 6 Illustrating a method of measuring effect of tire inflation

Fig. 6 shows what happens to tires when subjected to normal forces when properly inflated and when underinflated. A series of lines is drawn on the tire in a uniform pattern before the tire was distorted by loading it. Measuring from line to line, it was found in the case of the tire shown that, at the point of maximum stress, the sidewall distortion was 3 percent for normal or recommended inflation, 6 percent for 12½ percent underinflation, 10 percent

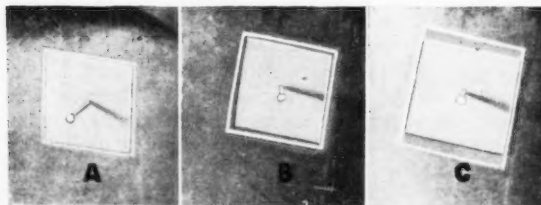


Fig. 7 Method of indicating the amount of stretch for various inflation pressures of a tractor tire

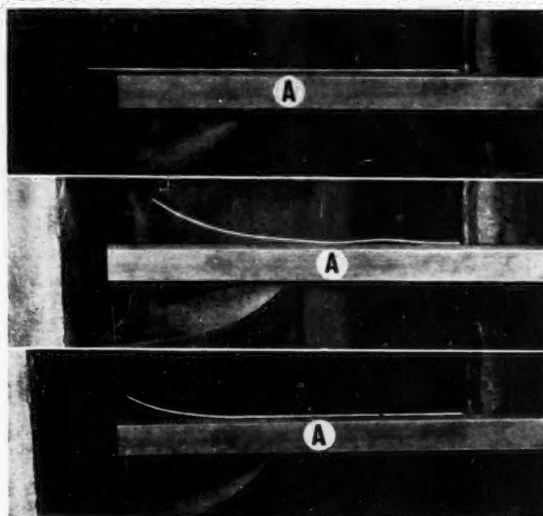


Fig. 8 These three views illustrate a method for observing distortion of tires under proper and improper inflation pressures

for 25 percent underinflation, and 17 percent for 37 percent underinflation.

Fig. 7 indicates the stretch of the stock when a tractor tire is subjected to various inflation pressures. A plastic square was placed on the sidewall of the tire and anchored at one point by a common pin. Fine white lines were drawn (*A*) on the tire, coinciding with the edges of the plastic square. When the load and torque are applied, the resulting stretch of the sidewall can be seen, since the lines will move with the sidewall, while the size of the plastic square will not change.

Fig. 7(B) shows the small amount of exposed sidewall between the lines and the plastic square in the properly inflated tire, while Fig. 7(C) indicates the excessive amount of exposed sidewall, between the white lines and the plastic square, which resulted when the tire was underinflated 25 percent.

When a tractor is pulling a good load, its driving tires are subjected to a twisting force or torque. To observe the extent the tires were distorted under proper and improper inflation pressure by this twisting action, a steel bar, *A*, was fastened to the hub of the wheel (Fig. 8, top). This bar rotated with the wheel and rim assembly when the torque was applied. A line was placed on the tire, parallel to the bar, and coinciding with the top edge of the bar. By applying the torque, the wheel, rim and tire started to rotate. Since the tread of the tire would not slip or skid, this portion of the tire did not move. The separation between the bar and the line on the tire (Fig. 8, center) resulted when the tire was inflated to 12 lb pressure but the load it carried required 16 lb for normal pressure. When properly inflated to 16 lb per sq in and carrying the same load, there was only a slight separation of the line and bar (Fig. 8, bottom).

In tires having low inflation, some degree of buckling occurs, but the buckles or wrinkles are not readily seen until the torque is applied. This is indicated in Fig. 9 (left), while the properly inflated tire in Fig. 9 (right) is free of such distortion.

(Continued on page 860)

Corn Dozer for Canning Plant

Kenneth A. Finden

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IN TERMS of total agricultural production the canning crop acreage is small, hence certain problems peculiar to the canning industry have escaped the engineering advances made in agriculture as a whole. Handling of green produce from the field to the canning plant has been one of these. This paper deals particularly with the case of sweet corn.

In the horse age all sweet corn was grown close to the plant, picked by hand and hauled to the canning plant in high wooden-wheel wagons. Eventually it proved economical to haul the corn to the plant in trucks. However, it is always necessary to maintain a certain reserve of corn at the plant and it did not pay to have trucks waiting to unload. To overcome this difficulty a scheme of unloading the trucks into the old high-wheeled wagons was devised. Thus the obsolete wagons served as a convenient storage means as they could be moved about and unloaded at will. This is the method used today by many corn canners; in fact, our company still has several hundred of these high-wheel wagons. The maintenance problems we have with equipment that farmers quit using thirty years ago can easily be appreciated. The extra handling of the corn during reloading also results in considerable damage.

A few years ago canners in Wisconsin starting using a system of dumping the corn on a concrete apron and then pushing it onto conveyors with a bulldozer as the corn was needed in the plant. Our personnel observed several of these installations, liked the operation, and decided to install this system at our Winsted, Minn., corn plant.

The concrete apron was laid out with 100-ft by 30-ft slabs on both sides of two 100-ft trench conveyors. The four slabs were designed to give a total storage capacity equivalent to about 10 hr of plant operation. In actual operation the loads were larger and occupied a greater space than we had anticipated. This resulted in a rather inefficient use of the area available and reduced the storage capacity to about 8 hr of plant operation. This reduced storage, however, did not seriously impair the operation of the system.

Since this was our first installation we were anxious to learn as much as possible. To determine the best conveyor

system, a belt conveyor was installed on one side and a flight conveyor with overhead return on the other side. The belt conveyor proved to be superior in all respects. The structure of the overhead return on the flight conveyor presented an obstacle for dozer operation and getting the corn to drop through the flights at the discharge also proved troublesome.

It was generally agreed the dozer should be on the rear of the tractor and the operating controls reversed to get the operator in a position where he could carefully meter the corn into the conveyors.

Several blade designs such as inverted V's were considered. Tests with scale-model blades on a toy tractor pushing soaked oats indicated, however, that a straight blade with considerable curvature and dividers extending beyond the blade gave the best blade capacity and good metering characteristics.

Enclosing the entire tractor with shielding was necessary to prevent ears being crushed under the wheels during operation. It was difficult to build the side shields rigid enough to resist the side push of the corn and yet be free to raise. By leaving the shields rather flexible and letting them butt against the tractor axle and a small frame toward the front of the tractor, it was possible to fasten the shields to the blade and mount the whole unit on a parallel linkage. Two hydraulic cylinders in the parallel linkage raised the whole unit. To maintain a constant blade and shield clearance, the entire unit floated on two rubber-tire swivel castors mounted under the blade.

A 3-plow row-crop tractor provided sufficient power and maneuverability, but the clutch requirement was considered critical so a John Deere A tractor was chosen due to its simple clutch replacement.

We estimated that the dozer would be able to push about 1500 lb per pass in a time cycle of about 1.75 min which was sufficient to maintain plant operating capacity. However, in the event of a breakdown a stand-by unit was considered necessary. A conventional dirt blade on a manure loader frame of a second tractor served as a stand-by unit.

Paper presented at the annual meeting of the American Society of Agricultural Engineers at Minneapolis, Minn., June, 1954. A contribution of the Committee on Agricultural Processing.

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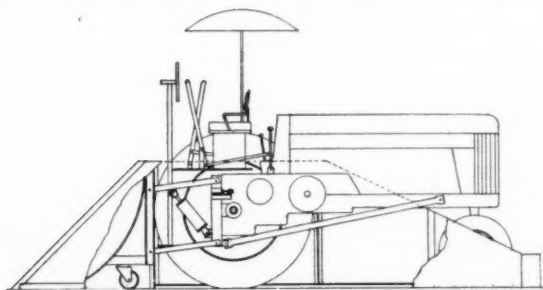


Fig. 1 Schematic drawing of corn dozer mounted on tractor

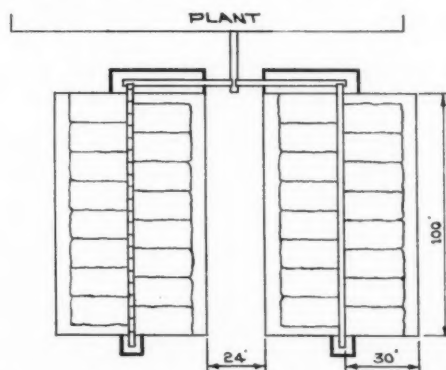


Fig. 2 Layout of concrete apron on which canning corn is dumped prior to pushing it onto conveyor for delivery to canning plant

In operation the dozer averaged 1,870 lbs per pass and had a cycle time of 1.28 min per pass enabling it to push corn at the rate of 45 tons per hour. Since the plant rate was less than this, the dozer worked only about 35 min out of every hour.

In an effort to determine the proper concrete finish that would give the maximum traction under wet conditions with the least corn damage, dynamometer tests were run with a tractor on various concrete finishes. A medium rough wood float finish was chosen as the most desirable. Areas close to the conveyor where traction was not a problem were given a smooth steel float finish.

Under actual operating conditions, traction was the limiting factor as far as blade load was concerned since the tractor could spin its wheels on the dry concrete even though two sets of wheel weights and fluid had been added to the tires. The worst condition observed was during a light misty rain which caused the smut and residue on the concrete to become very greasy. Dozer capacity dropped about 22 percent under these conditions. During heavier rains the concrete was washed clean and slippage was not as serious.

A track-type tractor or a 4-wheel-drive unit would no doubt be capable of pushing larger loads, but actually maneuverability and good operator position are just as important as ability to push large loads. Of the cycle time of 1.28 min, 0.82 min, or 64 percent, of the time was spent metering the corn into the conveyors; therefore, on larger installations capacity can be increased by increased conveyor capacity.

The question of slippage under wet conditions is, of course, important. We feel that keeping the tire inflation high to give the least rubber in contact with the concrete will do the best job of wiping the concrete dry and providing traction. Low inflation or dual wheels merely adds flotation. No doubt there are tread designs which would be better than the conventional tractor tire.

The general operation of the system was good. After the first few days there was no confusion or lost time. Trucks were weighed, dumped and on their way in about 10 min. A leadman, a relief operator, a dozer operator, a dozer and the stand-by unit replaced about 11 men, 3 tractors and 100 yard wagons.

There were no quality or sanitation problems. The corn did not heat while piled on the apron and the dozer kept the concrete relatively clean so there was never a collection of flies or any foul odors. Little clean-up was required except in the conveyor pits.

Studies made on damage to corn showed 20 percent fewer ears were damaged than with the conventional system. This represents a saving of 0.99 percent cut corn.

This system no doubt contributed to the fact that the Winstead plant had the highest number of cases per wage hour and above average cases per ton of green corn.

This year a similar system is being installed at our Belvidere, Ill., plant which has nearly double the capacity of the Winstead plant. The same type dozer will be used and we hope to handle the larger plant with one dozer and a stand-by unit. The apron will be wide enough to dump loads two deep perpendicular to the conveyor. It will be built with only one long belt conveyor so it will be approximately twice as long and twice as wide as the Winstead aprons.

Tractor Tire Inflation Pressures

(Continued from page 858)

Many more examples of distortion and excessive strain could be cited, all resulting from low-inflation pressure. However, it should be apparent from the foregoing that abnormal stresses and strains are placed on the tire when it is operated without sufficient inflation pressure.

What does all this mean in terms of performance? To get some of the answers, we have tested many tires under all conditions found in farming. In addition to our test activities maintained on the Firestone Farms at Columbiana, Ohio, we have followed field testing in many other localities. On one large ranch in the heart of the wheat-growing country, we have tested many tires on more than 50 tractors at one time.

Examination of the results of our tests on these tires showed that the two groups of tires, operated at 10 and 12 lb, or 25 to 37½ percent underinflated, developed radial cracks in half the tires in this group, after delivering only one-third their normal life expectancy. However, the control group operated at 16-lb pressure did not show any radial cracking.

Another test still going on has produced some significant results. One group of tires operating at 10 lb pressure has developed radial cracks after delivering only 1,100-hr service. Another group at 12 lb inflation, has developed cracks at 1,200 hr, while the third group at 16 lb pressure has been in service for approximately 1500 hr and shows no evidence of radial cracking. Additional tests at other locations have further substantiated these results.

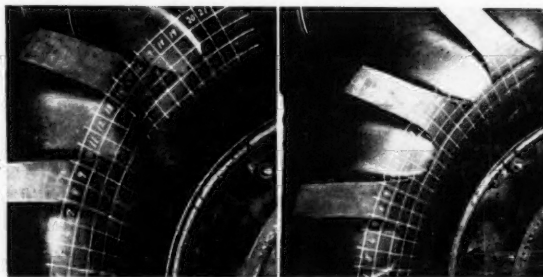


Fig. 9 The tire at the left shows a degree of buckling under low inflation which does not occur when the tire is properly inflated as shown at the right

The rubber industry has long recognized the importance of correct inflation pressure. The rubber companies have individually and collectively, through the Rubber Manufacturers Association, made material available to the tire dealers, implement dealers, implement branch houses and farmers stressing the importance of correct inflation. Operating conditions, size of tire in relation to the power of modern tractors and the weights carried on them, the sizes of tools pulled, and the higher operating speeds with the resulting heavier pull loads, have outdated the time when we can think of 12 lb inflation as the correct pressure for all rear tractor tires. If the farmer is to realize the maximum return from his investment in farm machinery, of which the rubber tire is an important part, he must be fully informed on the importance of correct inflation pressure.

Removal of Dents from Irrigation Pipe

Dale E. Kirk

Member ASAE

DENTS and kinks in portable irrigation pipe are a continual source of loss and aggravation to farmers using sprinkler irrigation equipment. Sprinkler-type irrigation with the use of portable surface pipe has been practiced on a commercial scale in various parts of the United States for the past 20 years. Until after World War II, various types of steel surface pipe were used. While this pipe or tubing varied a great deal in wall thickness, most of it had sufficient strength to be quite resistant to field damage. At the end of World War II, the war-born aluminum reduction and extrusion plants began producing an extruded thin-walled aluminum tubing which rapidly became the dominant material used for sprinkler irrigation. The rapid increase in the production of aluminum irrigation tubing is indicated in Fig. 1. Virtually all the aluminum

Agricultural engineer develops a method for applying the hydraulic radial expansion principle to the straightening of aluminum irrigation tubing.

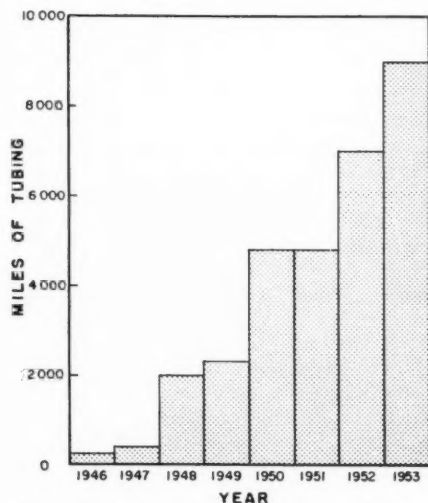


Fig. 1 United States production of aluminum irrigation tubing. (Data supplied by H. H. Nuernberger, Aluminum Co. of America)

sprinkler tubing produced prior to 1952 was extruded and designated as alloy 63S-t6. Since 1952, several manufacturers have been marketing a welded tubing from a harder alloy, which is somewhat more resistant to field damage.

Due to the lowered stiffness of aluminum, and the thinness of the tubing wall, aluminum irrigation tubing is much more susceptible than steel to field damage in the form of dents and kinks. With a modulus of elasticity and a density each approximately one-third that of steel, the deflection of an empty section of aluminum tubing supported at the ends will be approximately equal to the deflection of

a steel tube with the same dimensions. When loaded with water, the deflection of aluminum is much greater.

The types of damage which appear to be most common are dents due to radial impact and kinks due to excessive bending. While a section of tubing occasionally may be cut or torn, the damage from handling or by accidentally driving over the tubing with automobiles, trucks, tractors and other farm implements, usually leaves the material intact. A large dent or flattened area will cause the pipe to kink or be offset unless the ends are restrained. These various incidents in the original shape of the tubing always cause some change in the normal pattern of flow of water through it. However, a farmer is generally more concerned with the inconvenience of handling kinked sections which tend to twist in the hands when they are carried. These sections will not lie in proper position for coupling and will not stack up well with the other sections in a moving wagon or truck rack.

A repair may be made by cutting out the damaged section and fitting a new coupler to one of the cut ends. This repair is expensive and leaves two shorter sections, which are again a problem to handle with the other uniform-length sections. For a 3-in.-diam line, the cost of a coupler is approximately equivalent to the cost of six to ten feet of tubing.

Most attempts to repair dented sections by malleting the tube against a projectile-shaped mandrel forced inside against the dent have been slow and costly and left the tubing in a rough and unsatisfactory condition. For large dents, this process necessarily involves excessive bending and stretching of the metal near the regions malletted.

Radial Expansion Method of Repair

In an effort to avoid the shortcomings of the mallet method of repair, the possibilities of the hydraulic expansion method were explored. The basic principle was to apply liquid under pressure to the inside of the pipe to remove the dents much in the same way that wrinkles are removed from a paper bag when blown full of air. Any tendency for the tubing to deviate from a circular cross section in the dented region would be from the bending stresses set up in the metal wall. By setting up the proper radial and hoop stresses, these bending stresses can be sufficiently overcome to make the tubing approach a circular cross section before excessive hoop yielding occurs.

The yield stress of alloy 63S-t6 extruded aluminum tubing was taken as 30,000 psi. The liquid pressure required to produce this stress was computed by the thin-walled cylinder formula, $P = 2St/D$, in which P is the gage pressure in pounds per square inch, S is the mean circumferential stress in pounds per square inch, t is the wall thickness in inches, and D is the inside diameter in inches.

Paper prepared expressly for AGRICULTURAL ENGINEERING. Authorized for publication on September 22, 1954, a Technical Paper No. 874 by the Oregon Agricultural Experiment Station. Much of the test material was taken from a thesis for the master of science degree by the author while attending Michigan State College.

The author—DALE E. KIRK—is associate professor of agricultural engineering, Oregon State College.

These computed limiting pressures are about 1580 psi for 2-in and 1030 psi for 3-in tubing where 0.050-in wall thickness is used. The sizes 4-in through 10-in run from 630 to 960 psi and are not an exact function of diameter since various wall thicknesses are used.

The hydraulic radial expansion method was tested on extruded 3-in aluminum tubing which is a size commonly used for laterals. There is no reason to believe this method of repair will not work equally well on welded tubing so long as the seams are up to nearly full strength of the wall and have no appreciable inside flash.

End Plug Design

One key to the successful application of the radial expansion principle is a satisfactory end plug design. Some of the requisites of a satisfactory end plug are as follows:

- A perfect tight seal against liquid pressures up to 1,500 psi.
- Withstand end forces ranging from 4500 lb for 2-in tubing up to 50,000 lb for 10-in tubing
- Adaptable to various lengths and diameters of tubing
- Accommodate various types of loose and rigid couplers
- Ends of the tubing not to be restrained but left free to move as the kinks are removed
- Sufficiently portable to transport readily to the farm
- Reasonable in cost.

The plug design illustrated in Fig. 2 embodies most of the requisites listed above. The liquid seal is maintained by a molded rubber cup (A) which is seated against the main plug body (B). End thrust on the plug is resisted by the friction obtained from pinching the tubing between the expanding segments (C) of the plug body and a hinged detachable retaining band (D) placed around the outside of the tubing.

The expanding segments are forced outward by a tapered bronze core (E) fitted inside the plug body. Three hollow concentric shafts are used to carry the control handles out beyond an attached coupler. The outer shaft (G) is threaded onto the plug body and carries the bronze core. Turning the handle attached to this shaft forces the body segments outward against the tubing. A handle attached to the intermediate shaft holds the body in place for tightening.

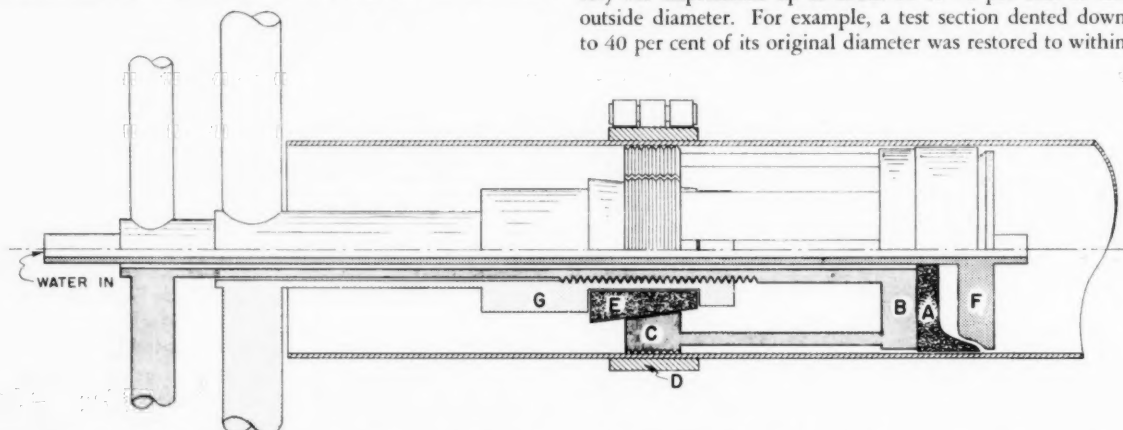


Fig. 2 Schematic drawing of plug used to seal the ends of aluminum irrigation pipe so that hydraulic pressure may be applied

The inner shaft serves as a pipe to carry water into the tubing. The inner end of this inner shaft carries a mushroom-shaped head (F) which fits against the inside of the rubber cup. When difficulty is encountered in making the rubber cup seat properly against a piece of misshapen tubing, the mushroom head can be pulled into the cup to force it more firmly against the tubing inner wall.

The same type plug may be used for the plain end of the tubing as well as the end fitted with a coupler. The plug used on the discharge end of the tubing should have the inner tube fitted with an elbow and a short riser which will just clear the tubing wall. The outer end of the inner tube should be fitted with a valve for holding pressure inside the tubing. By having the riser in the same plane as the handle of the valve, this riser can easily be kept in a vertical position for scavenging out the last bit of air as the tubing is filled with water.

It is necessary to have a pair of plugs for each diameter of tubing to be straightened. One pair of plugs should, however, accommodate various types of loose and rigid couplers of a given tubing size so long as the coupler does not provide a serious obstruction beyond the interior of the tubing wall. These plugs are quite portable and, since flexible liquid connections may be used, there is no appreciable restraint to the ends of the tubing as the kinks are removed.

Dent-Removal Tests

Three types of damage were inflicted on 3-in-diam extruded tubing to check the effectiveness of the radial expansion method in restoring the apparent original shape and dimensions. The first series of dents was made by use of a straight, sharp-edged 90-degree V-shaped tool impressed at right angles to the tubing axis. This series showed that such dents could effectively be removed if the depth of impression was no more than 40 to 50 per cent of the original outside diameter of the 3-in tubing. Deeper impressions with this sharp tool tended to cut through the wall near each end of the impression.

The second series of dents was made with a straight, round-edged tool having a $\frac{1}{8}$ -in radius. This tool was also impressed various depths at right angles to the tubing. Fig. 3 shows a typical load-deflection curve when these impressions were made in 3-in tubing. Dent removal was satisfactory for impressions up to about 60 to 70 per cent of the outside diameter. For example, a test section dented down to 40 per cent of its original diameter was restored to within

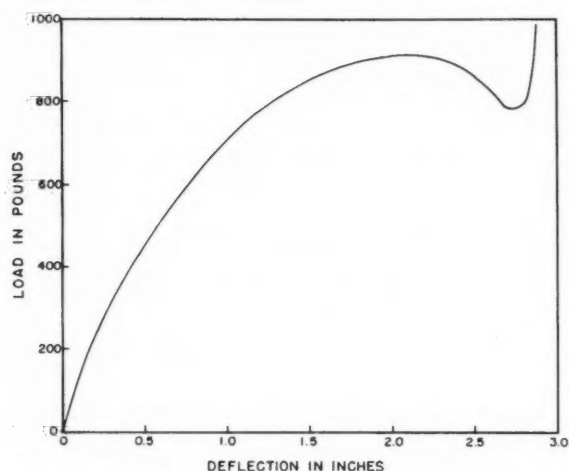


Fig. 3 Load-deflection curve for 3-in O.D. tubing dented by $\frac{1}{8}$ -in radius bar

92 per cent of the original diameter without the aid of any external malleting or bending.

The third series was made up of 3-in-diam tubing test sections which had been mashed by driving over them with trucks, cars, and various sizes of tractors. Where the dent was formed by a low-pressure-type tractor or automobile tire, the hydraulic expansion method of removal was very

effective. In most cases the residual dent was less than 0.10 in as measured by an outside caliper. When the residual oblateness in the damaged area was removed by squeezing the section in a vise, the outside caliper could detect very little variation in diameter.

The series of pictures in Fig. 4 shows the shape of recovery of one of the test sections as pressure was applied. The steps as shown on the gage were at no pressure, 100, 200, and 700 psi. This sample had been run over with the rear wheel of a tractor which exerted a 1450-lb force on the tubing. The small hand pump shown in the background was used to supply the hydraulic pressure.

The tests showed that pressures up to 800 psi would not cause yielding or rupture in three-inch material so long as the metal was not badly corroded, cut or sharply crimped. The typical diametral recovery pattern with increased pressure is shown by the curve in Fig. 5.

The small amount of kink or offset that is left after the dent is removed may easily be removed while the tubing is under pressure. The bending moment necessary to stress the 3-in tubing beyond the yield point is reduced by one-third when under 700 psi internal pressure. This internal pressure is also very useful in protecting the tubing from further denting and collapse at the points where the bending moment is applied.

Friction Loss Study

While the loss in pressure due to dents in a sprinkler

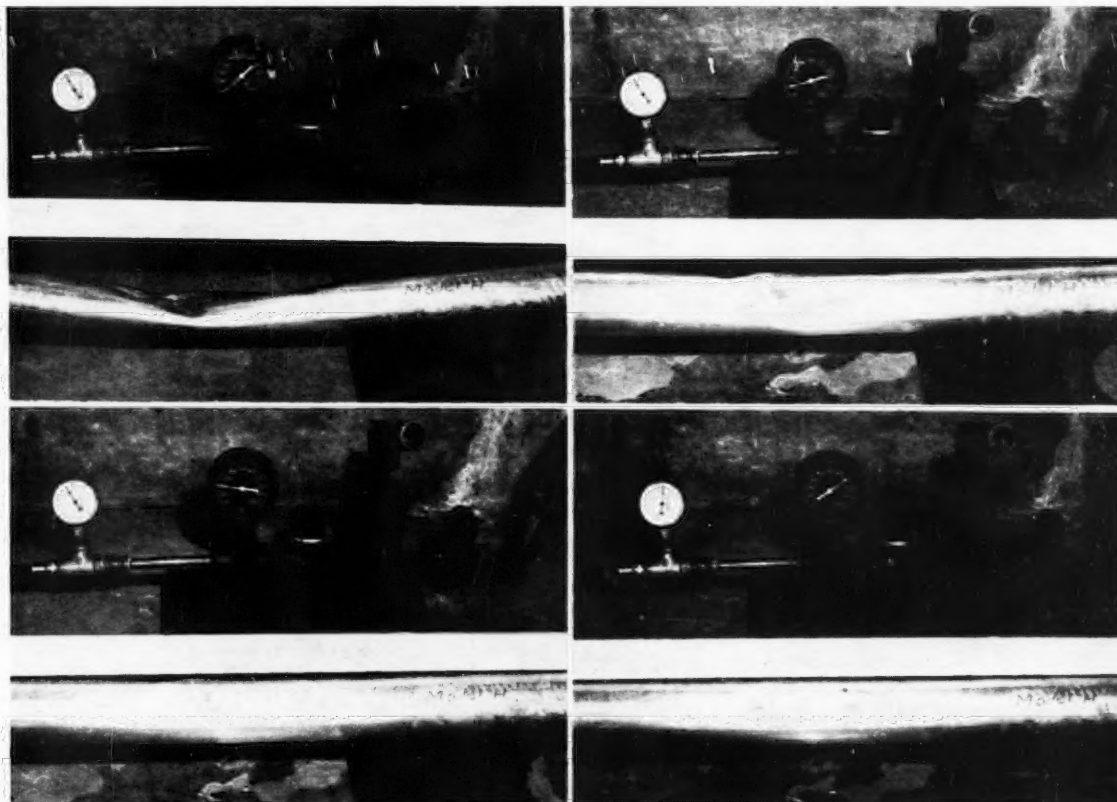


Fig. 4 Straightening series showing the effect of applying internal pressure. The four steps shown are at zero pressure (upper left), 100 psi (upper right), 200 psi (lower left), and 700 psi (lower right)

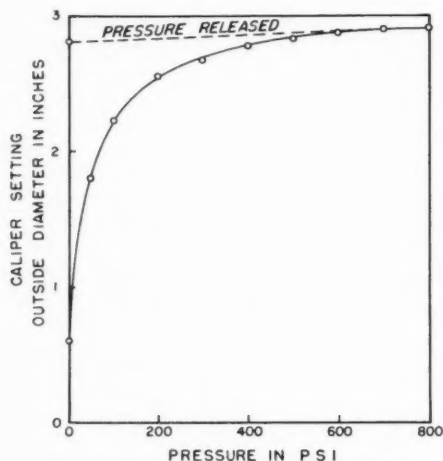


Fig. 5 Curve showing the outside caliper setting which would just clear the dented area as pressure was applied

system is not usually considered a serious problem, a general evaluation of this loss is of interest. After the tractor had passed over the tubing shown in Fig. 4, an outside caliper set at 1.28 in could be passed over the damaged area. Laboratory measurement of the friction head at various rates of flow were made for the tubing before it was damaged, while it contained the dent, and after it was straightened. Fig. 6 shows the friction curves for a 4½-ft test length. Constants for the general equation $H = KQ^m$ were computed by the method of least squares for each of the three curves. For all of the samples tested, there was no significant difference in these constants for the intercept and the slope of the curves for the tubing before it was damaged and after it was repaired by radial expansion.

An example with the necessary assumptions can show the general extent of the power loss if the dented sections above were placed in service. Assuming a flow rate of 170 gpm, 20 hr per day operation, 50 per cent over-all pumping efficiency, and an electrical cost of 2¢ per kw-hr would give a cost of 23¢ per month for pumping water past such a dent. This figure could be significant were it not for the fact that a pipe damaged in this manner generally would not be tolerated in service by the farmer. It is surmised that general defective appearance and difficulty in handling would cause most damaged pipe to be pulled from service before the added friction loss becomes a factor.

Bending Strength Recovery

For any method of dent removal to be acceptable it should effectively restore the damaged tubing to near its original bending strength. Restoration of shape and hydraulic characteristics should not be considered sufficient if the reclaimed section must be given favored treatment in the field to prevent kinking at the originally damaged area.

A replicated experiment was set up using two groups of six tubing samples each. Each sample consisted of a section of new 3-in O.D. aluminum tubing 5 ft long. The six sections in the one group were crushed as uniformly as possible by a tractor rear wheel, which exerted a 1450-lb force. Each of the dented sections was then subjected to 750 psi hydrostatic pressure and the residual offset of approximately 0.2 in at the center was removed by applying a

bending moment before the pressure was relieved. Each of these sections was then placed in a universal testing machine and subjected to third-point loading as a simple beam. The damaged and repaired area was placed in the machine in such a position that it would be loaded in compression where it would have the greatest tendency to buckle. The other group of six samples was also placed in the testing machine and loaded to the point of failure in a similar manner. The load-deflection curves plotted from the observation of these tests showed that the bending strength of the damaged sections was very near the strength of the undamaged sections up to the proportional limit of each. Beyond the proportional limit the damaged sections soon buckled and the curve fell off more rapidly. There was more of a tendency for the undamaged sections to become plastically deformed into a smooth, curved shape before buckling. From the practical standpoint, however, the bending strength within the nominal elastic range of undamaged tubing appeared to be a reasonable criteria for comparison. Loading beyond this point would cause permanent deformation whether the section was previously damaged or undamaged. For the type of damage inflicted in this test series the repair procedure restored the proportional limit in bending to an average of 95 per cent of the value for undamaged tubing.

Summary

The application of the hydraulic radial expansion principle appears to be quite practical for the straightening of aluminum irrigation tubing. Field damage consists mostly of dents and kinks from rough handling, dropping and

(Continued on page 869)

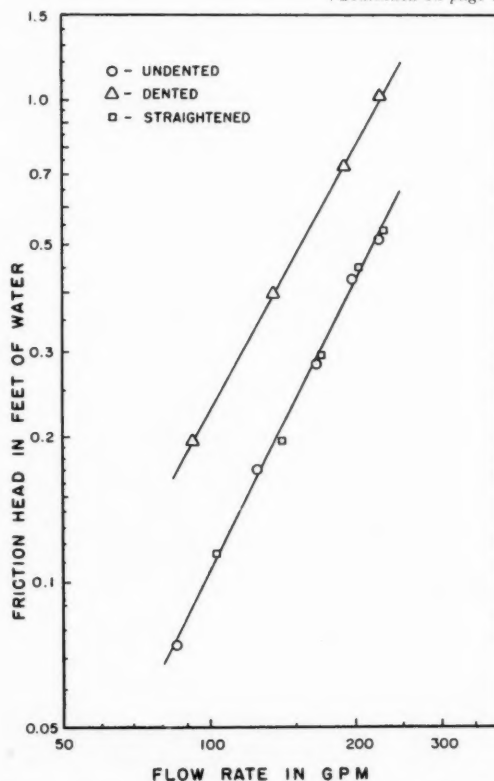


Fig. 6 Friction head for test sample of 3-in O.D. tubing 4.5 ft long

Application of High-Frequency Electricity to Young Chickens

D. T. Kinard and D. E. Wiant

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Experimental Results Show No Marked Effect on Gain in Growth and Feed-Conversion Efficiency

THIS paper reports the results of experiments in applying high-frequency electrical treatment to young chickens to determine its possible effect on growth and feed-conversion efficiency.*

Electrical phenomena associated with living things have been a subject of study for over a hundred years. The presence of the electrical environment of the earth and concepts of the constituency of matter imply close relationships between electricity and life processes. Living things exhibit electrical properties, and many vital processes are somewhat electrical in nature. The impression of external electrical potentials of different types and magnitudes on living systems are known to produce various biological effects. Although many questions related to those findings are yet in the hands of the biologists, at least one report has appeared to justify the attention of those agricultural engineers whose major interest is in the field of electricity in agriculture.

Baker (3, 11, 18)† applied high-frequency electrical treatments to young chickens and reported that treated birds grew a third or more faster, had a more efficient feed conversion, and feathered earlier than those untreated. His experiments were interrupted by World War I. Aside from the present study, apparently no further work has been undertaken to investigate the ideas suggested by the earlier report.

March and Beams (10) and others (16) have obtained interesting effects on growth by the application of continuous currents. Marked differences in growth resulting from the application of high-frequency fields have not been reported, although seed exposed to some of these treatments are improved in germination and perhaps otherwise (1, 8), suggesting a possible influence on growth. Effects on living systems exposed to high-frequency treatments have been attributed by numerous investigators largely to the heat developed by such treatment and not solely to factors purely electrical, though the latter has been claimed (14). Baker's

experiments involved very small amounts of energy, probably too little to produce effects from heat. Although continuous currents are employed effectively in very low intensities, most of the high-frequency experiments have involved exposure of animals or material to rather intense fields. Baker's theory is that "minute currents, comparable with those in nature," cause a better metabolism, resulting in more efficient utilization of feed and faster growth. Chickens respond to lighting (6, 16). That they may also respond to small amounts of radiated energy of much greater wave length is suggested by theories that birds may sense electromagnetic waves (12).

The evidence recorded by Baker (3) is not convincing. On the other hand, he is a man of integrity and of considerable technical background (15). Still active, he affirms his faith in the treatments (4). There have been, apparently, no other experiments quite similar to his on chickens. The literature does not provide the evidence to refute or confirm his claim.

Experimental Procedure and Results

The present work was intended to determine if marked response in growth of young chickens might be obtained by the application of treatments similar to those used by Baker. If results were positive, the study was to be pursued toward practical ends. Chicks were grown to about age six weeks under the influence of the electromagnetic field within coils energized at different frequencies and at different intensities from high-frequency generators. Treatments considered similar to the original ones and related treatments, were tried. Treated and untreated birds were compared primarily on the basis of gain and feed-conversion efficiency. Five experimental trials were involved, three at Michigan State College on White Rock chicks, and two at the University of Georgia on New Hampshire cockerels during the period January, 1953, to March, 1954.

In the original experiments, Baker used the high-frequency output of an induction coil to energize several turns of conductor about a six-deck pen holding the birds. That helix around the pen served as an antenna in a circuit like that of the wireless telegraph, common at the time. The chicks were in that manner exposed to a mild treatment by high-frequency induction. A 4-v battery supplied the power to the Ruhmkorff coil. Treatments were applied 10 min every hour or for 20 min three or four times a day. During treatment, a distinct shock was felt on touching the birds, and a spark was observed as they pecked at a finger. Some important details of the experiments were not described, including the manner in which the control birds were handled. Baker (4) in 1941 used a static transformer, in place of the induction coil, connected directly to a 230-v, a-c supply. Otherwise the circuit was the same. Presumably the results were the same. The use of different equipment and variations in the treating program suggest that some varia-

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*Kinard, D. T. Growth experiments on young chickens exposed to high-frequency electrical treatment. Unpublished Ph.D. thesis, Michigan State College, 1954.

†Numbers in parentheses refer to the appended bibliography.

tions in the treatment were not critical.

In this work, it seemed reasonable to expect that use of a treatment patterned after the original ones, to the extent permitted by information available, might produce some evidence of stimulation. Accordingly a treatment similar to the original was used in each experiment. As the induction coil is more difficult to control and less stable than vacuum-tube transmitters, more modern equipment was selected to provide additional treatments having differences in frequency and total power output. Radio transmitters and a short-wave generator, normally used in human therapy, were used to broaden the scope of the exploratory treatments. All experiments were shielded with conducting screen and other steps taken to prevent interference with high-frequency communications.

Three-deck battery pens of wood frame, plastic screen, and fiberboard floors were used to hold experimental groups of 40 to 60 chicks up to age six weeks, 15 to 20 birds on each deck. Pens to be treated were encircled by ten turns of No. 12, type TW conductor, spaced about 3 in apart forming a helix $2\frac{1}{2} \times 3$ ft in cross section. Treatment was accomplished by energizing this coil with a source of high frequency at periodic intervals or continuously. Chicks were all fed alike, *ad libitum*, on a standard chick-starting ration in trials 1, 2 and 3 and on a standard all-mash broiler ration in trials 4 and 5. Chicks were weighed individually once a week. Feed was weighed in as required and weighed back weekly, as the birds were weighed, to provide data on feed conversion by groups. All chicks were wingbanded for individual identification. Simple experimental designs were used, and an analysis of variance was applied to all gain data.

Initially, three groups of 48 White Rock chicks each were compared. One group was treated as in the early experiments. A 3-in (spark) induction coil supplied by a 6-v battery provided the source of high frequency (Fig. 1). Power input was about 24 w, 4 amp at 6 v, d-c operating

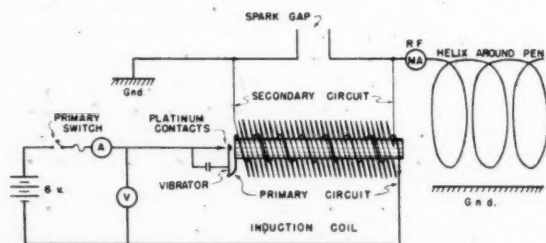


Fig. 1 Circuit of the induction coil used as a source of high-frequency current for treating chicks in non-conducting pens. This circuit is patterned after that used in the original experiments

with a $1\frac{1}{2}$ -in spark. Total power output was estimated (2) at 12 w or less. Radio-frequency current between the induction coil and the first turn of the helix about the pen was 340 ma. Energy transfer to the chicks was not measured. The phenomena noted by Baker, the glow of a gas bulb and the spark as one touched a chick, were observed in these experiments. Predominant frequency of the induction coil ranged from less than one to about two megacycles. For a second treatment, an ARC-5 transmitter operating at six megacycles was used (Fig. 2). Estimated total power output was about 17 w. Radio-frequency current between the antenna terminal and the first turn of the helix about the pen was about 600 ma. Treatments were administered four times

daily for 20 min at a time at intervals of 3 hr, trial 1, and 4 hr in trials 2 and 3, beginning at 8:00 a.m. Treatments were begun on day-old chicks and continued for six weeks

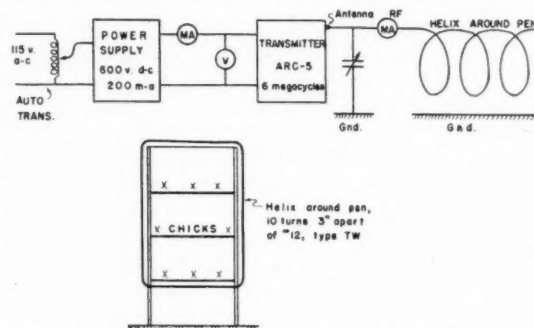


Fig. 2 Circuit for a radio transmitter used for additional high-frequency treatments of chicks

in trial 1. In trials 2 and 3, the treatment period extended from the time chicks were one week old until they were six weeks old.

Results of trials 1 and 3 are shown in Tables 1 and 2. No significant differences in gain or feed conversion are

TABLE 1. GAIN AND FEED EFFICIENCY OF WHITE ROCK CHICKS EXPOSED TO HIGH-FREQUENCY FIELDS, DAY OLD TO SIX WEEKS OF AGE, TRIAL 1

Treatment group	Sex	No. of chicks	Mean gain, grams	Std. dev., grams	Feed-gain both sexes
Untreated control	male	26	565.7	42.3	
	female	22	487.6	45.3	2.56
Induction coil	male	29	557.7	41.6	
	female	19	482.4	38.2	2.57
Transmitter (6 meg)	male	32	544.3	49.2	
	female	16	488.4	51.3	2.61

F test for significant differences between treatment gains: Actual, 0.1; required at 5 percent level, 3.07 for 2 and 140 deg of freedom. Sex differences highly significant; interaction not significant, pooled with error (m.s. 2048).

Initial individual mean weights, grams: control, 40.8; induction coil, 40.1; transmitter, 40.2

Estimated total power output to the antenna encircling the pen: induction coil, 12 w; transmitter, 17 w.

indicated. The second trial was partially invalidated by failure of the control group to develop normally in the first week prior to beginning treatments on the other two groups, and the data are omitted. The third trial confirmed the first

TABLE 2. GAIN AND FEED EFFICIENCY OF WHITE ROCK CHICKS EXPOSED TO HIGH-FREQUENCY FIELDS, DAY OLD TO AGE SEVEN WEEKS, TRIAL 3

Treatment group	No. of chicks	Mean gain, grams	Std. dev., grams	Feed-gain ratio *
Untreated control	36	644.4	108.3	2.78
Induction coil	33	617.3	112.7	2.98
Transmitter (6 meg)	36	633.8	81.0	2.96

F test for significant differences between treatment gains: Actual, 0.6; 5 percent level, 3.04 at 2 and 102 deg of freedom.

Initial individual weights, grams: control, 35.8; induction coil, 33.9; transmitter, 34.2

* Feed records cover final four weeks.

one. No birds were lost in the first experiment. Loss of three in the third trial was attributed to cause other than the treatment.

In the fourth trial, located at the University of Georgia,

two electrical treatments and a control were used, each with a replication. A sample of 324 New Hampshire cockerels was selected at age two weeks from 500 cockerels which were raised together in a brooder house. The 324 birds were divided into 18 lots, approximately equal in weight and range of weight, which were placed in six three-deck pens. One induction coil was used to treat two pens, and a radio transmitter operating at 32.5 megacycles, having an estimated output of 20 w, was used to treat two pens. Two pens were untreated. The positions of the pens were randomized in a 14 x 20-ft shielded enclosure. Treatments were administered for 20 min four times daily at intervals of four hours as before until the birds were six weeks old. Intensity of the treatment in each case was roughly half that in the preceding experiments. Results are shown in Table 3.

TABLE 3. GAIN AND FEED EFFICIENCY OF NEW HAMPSHIRE COCKERELS EXPOSED TO HIGH-FREQUENCY FIELDS, AGE TWO WEEKS TO AGE SIX WEEKS, TRIAL 4

Treatment group	No. of chicks	Mean gain, grams	Std. dev., grams	Feed-gain ratio
Untreated control	101	548.7	60.2	2.80
Induction coil	103	569.6	64.4	2.81
Transmitter (32.5 meg)	100	565.6	59.4	2.79

F test for significant differences between treatment gains: Actual, 3.30; 5 percent level, 3.03, and at 1 percent level, 4.68 at 2 and 301 deg of freedom.

Initial individual mean weight of chicks in each group, 169.5 g at age two weeks.

Although significance at the five per cent level in favor of the induction coil group is indicated, this difference was considered to be caused by a mild cold among the chicks during their fifth week, which apparently affected the control group slightly more than the others. The difference was caused by reduced gain for the fifth week only for the control. Differences in gain were not significant during the other weekly periods. Thus no differences are attributed to the treatments. The accuracy of this comparison was disturbed by the presence of 17 females and loss of three birds from the group. Data for those individuals were not included in the final analysis. Feed over gain ratios include all birds participating and do not suggest differences between groups.

A preliminary histological examination, by the laboratory of the University of Georgia poultry department, of endocrine tissues (pituitary, thyroids, adrenals, and testes) from a sample of ten birds from each treatment group revealed no evidence of treatment effect.

In the fifth trial, eight electrical treatments were in-

cluded. New Hampshire cockerels were selected as before on the basis of weight at age two weeks.

In the first of two parts of the experiment, four pens were used to house four experimental groups of 54 birds each. One pen was used as a control, and each of the other pens was given a different treatment. As a possible means of eliminating questions of time or intervals between treatments, those three groups were exposed continuously to treatment from age two weeks to age six weeks. One treatment was provided by the induction coil having a d-c input of 2 amp at 6 v and operated with a 1/4-in spark. Predominant frequency was about 1.6 megacycles and the radio-frequency current, measured as before, ranged from 100 to 200 ma. A second treatment was provided by an ARC-5 transmitter at a frequency of 6 megacycles having an estimated total power output of 10 w. A third treatment, intended as an additional check on the high-frequency treatments, was arranged by installing aluminum sheets above and below the chicks on each of the three decks of the pen, and applying d-c high voltage to those plates. A 15,000-v, 30-ma, luminous tube transformer was connected as a half-wave rectifier for this purpose. Chicks on the top and bottom decks were grown between conducting plates held at a constant high potential difference, negative overhead. Chicks on the middle level were exposed to the opposite polarity. The arrangement afforded an average voltage gradient of about 8000 v across the one-foot height of each level. When the chicks were five weeks old, this treatment had to be discontinued as some of them became tall enough to complete the circuit between plates. Treatments in this portion of the experiment were applied continuously to the chicks from age two weeks to age six weeks, with the exception noted.

No evidence of an influence of the treatment on gain or feed conversion was developed (Table 4).

TABLE 4. GAIN AND FEED EFFICIENCY OF NEW HAMPSHIRE COCKERELS EXPOSED CONTINUOUSLY TO HIGH-FREQUENCY FIELDS, AGE 2 WEEKS TO 6 WEEKS, TRIAL 5

Treatment group	No. of chicks	Mean gain, grams	Std. dev., grams	Feed-gain ratio
Untreated control	53	595.3	61.9	2.30
Induction coil	54	601.8	60.4	2.34
Transmitter (6 meg)	54	609.4	46.6	2.21
High voltage, d-c	54	590.0	37.6	2.34

F test for significant differences between treatment gains: Actual, 1.77; 5 percent level, 2.65 at 3 and 203 deg of freedom.

Initial individual mean weight of chicks in each group: 159.9 g at age two weeks.



Fig. 3 (Left) Arrangement for exposing groups of ten chicks to the high-frequency field produced by a radio transmitter. (The pen is non-conducting) • Fig. 4 (Right) Short-wave generator used for intense treatments of groups of ten chicks. The machine is one commonly used for human therapy

In the second portion of the experiment, seventy birds comprising seven experimental groups of ten were housed in individual cages to obtain individual feed-conversion data. Positions of individuals were randomized. The ten birds comprising a group were removed from their cages daily for exposure as a group and then returned to their cages. Five groups were treated from age three to age seven weeks; two were untreated.

Two groups were exposed for 90 min daily to treatments differing in frequency. A coil 2 ft in diameter, 2 ft long, of 1/2-in copper tubing (Fig. 3) was connected as a loop antenna to either of two radio transmitters, each having a total power output estimated at 15 w. Frequencies were 6 and 32.5 megacycles. Chicks were placed in a box of plastic screen within the coil. As in the previous experiments they exhibited no evidence that they were aware of the presence of the electromagnetic field.

Three other groups were exposed respectively to three intensive treatments, each different in time of exposure, at a frequency of 16 megacycles. A short-wave generator operating with an output of 75 to 100 w was used to energize an induction cable, looped three turns 6 in apart around a non-conducting pen just large enough to accommodate the ten chicks (Fig. 4). The machine was one commonly used for human therapy and was equipped with a standard induction cable. One daily exposure of 30 min appeared to be all that the chicks could safely endure. The second exposure was 15 min, and the third, 8 min. During these treatments as was to be expected, heart and respiratory activity of the chicks was increased rapidly as the treatment was applied, and body temperature was raised from about 106.2 F (normal) to 110.2 F under the 30-min exposure. Responses, proportionately milder, were observed for the shorter exposures. These increased metabolic activities became normal in about 20 to 25 min following the treatment (Figs. 5 and 6). Temperatures were measured rectally at 3/4 in with clinical thermometers. Heart activity was measured using a cardio-vibrometer (13). Energy transfer to the chicks was estimated to be at the rate of 6 to 10 Btu per hr per bird. This estimate was based on the temperature rise of a 0.2 per cent concentration of NaCl in water held in ten glass containers, each holding a weight equivalent to a chick. The containers were used to replace the chicks within the treating coil and were exposed to the same treatment. That solution has an electrical conductivity under those conditions comparable to that of human tissue (14). Room temperature

was approximately 72 F. at approximately 60 percent relative humidity, typical for the entire experiment. Environmental temperature and, undoubtedly, relative humidity had an influence on the capacity of the birds to endure these treatments. Lower temperatures noticeably relieved the stress of the treatment. The procedure suggests a possible means for learning more of the capacity of chicks to withstand and rid themselves of heat.

Gain and feed data are shown in Table 5 and suggest no differences between treatments.

TABLE 5. GAIN AND FEED EFFICIENCY OF NEW HAMPSHIRE COCKERELS INDIVIDUALLY HOUSED, EXPOSED TO HIGH-FREQUENCY FIELDS IN GROUPS OF TEN, AGE 3 WEEKS TO 7 WEEKS, TRIAL 5

Treatment group	No. of chicks	Mean gain, grams	Std. dev., grams	Feed-gain ratio
Untreated control	10	735.8	82.5	2.77
Transmitter, 6 meg, 90 min	10	736.7	81.4	2.67
Transmitter, 32.5 meg, 90 min	10	759.7	47.0	2.57
S.W. generator, 16 meg, 30 min	10	740.1	88.9	2.68
S.W. generator, 16 meg, 15 min	10	738.3	107.0	2.75
S.W. generator, 16 meg, 8 min	10	733.6	37.4	2.85
Untreated control	10	688.5	95.7	2.89

F test for significant differences between treatment gains: Actual, 0.7; 5 percent level, 2.16 at 6 and 63 deg of freedom.

Initial weight of individuals: approximately 272 g at 3 weeks.

Measurements of heart and respiratory activity of birds exposed to the continuous treatments and to the two 90-min treatments were abandoned when it was found that application of those mild electromagnetic fields produced no change in the normal rates. Random measurements among the groups detected no evidence of differences between groups, and it was obvious that differences, if any, were small. The mean heart rate of one typical set of 47 observations on 5-week old New Hampshire cockerels at rest was 320.5 beats per minute; the respiratory rate had a mean of 37.3 breaths per minute with a standard deviation of 4.5. These figures are comparable with published data (12).

A preliminary histological examination of some of the endocrine glands of a sample of five birds from each of the experimental groups as before revealed no evidence of a treatment effect.

Discussion of Results

Since apparently no marked differences in gain were developed in the experimental birds, between those exposed to high frequency and those untreated but handled alike,

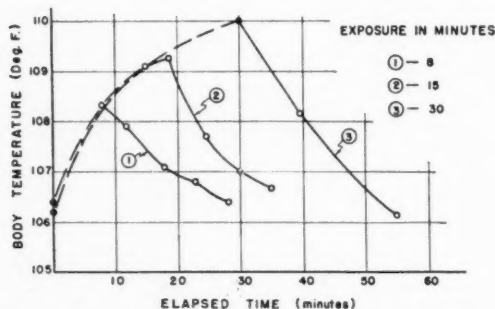


Fig. 5 Changes in body temperature of chicks exposed to intense treatment of high-frequency induction for 8, 15, and 30 min at a frequency of 16 megacycles. Each point is the mean of readings on five birds, members of a group of ten (Fig. 4)

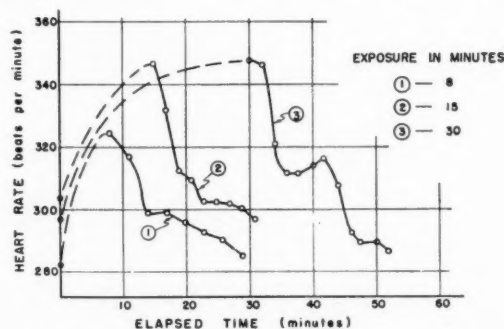


Fig. 6 Changes in heart rate of individual New Hampshire cockerels at age 5 weeks exposed to intense treatment of high-frequency induction at a frequency of 16 megacycles (Fig. 4)

either the original treatment was not closely approximated in this work, or the observed differences previously attributed to such treatment were caused by other factors. It cannot be said that the treatments used in this work were identical with those used originally. However, some degree of close approximation is established. Furthermore, treatments used in these experiments were varied in frequency, intensity, and in schedule of application, thus broadening the scope of possibilities of this investigation. The importance of the question of duplication is therefore somewhat minimized.

As commonly observed in growth experiments, significant differences in rates of growth of similar chickens may be caused by slight differences in such things as environment, care and handling, method of feeding, and other factors. Using present techniques, involving experimental designs to permit conclusive statistical analyses, researchers still are plagued with those many variable factors which are difficult to control. It is perhaps unlikely that the early comparisons were made in a manner which would bear critical analysis by present standards.

The number of electrical treatments considered in this work was limited. Although the procedure used does not offer promise of yielding positive results in terms of growth, it is possible that some other approach based on more complete information about the natural potentials of the bird might be more fruitful. The application of intense high-frequency treatments might be useful in studies of the capacity of birds to endure the addition of heat and to rid themselves of heat under different environmental conditions.

Summary

Young chickens were exposed to the electromagnetic field within coils energized at different frequencies and at different intensities from high-frequency generators to determine the possible effects on their gain and feed-conversion efficiency. Marked responses attributed to such treatment had been reported.

No marked differences caused by the treatments were found between treated and untreated chicks as measured in terms of gain and feed-conversion efficiency. Nor did there appear to be any change in the treated chicks to suggest the need for other measurements of their growth or behavior. A preliminary histological examination of endocrine tissues from samples of birds from some of the experimental groups did not reveal any evidence of treatment effect. Birds exposed to very intense treatments did experience, as was to be expected, a rise in body temperature and increased heart and respiratory activity, which became normal a few minutes after treatment.

It is considered likely, in view of the present findings, that the differences in gain and feed conversion previously observed were caused by factors other than the high-frequency electrical treatments.

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Removing Dents from Irrigation Pipe

(Continued from page 864)

running over the tubing with various farm implements. This type of damage can be repaired as long as there are no cuts, tears, sharp crimps or other weakened areas to cause premature rupture under pressure.

Laboratory tests showed that by closing the ends of the tubing with suitable plugs and applying hydrostatic pressure up to approximately 75 per cent of the yield stress of the tubing, the dents were removed for most practical purposes. Any slight residual kink left in the section could be removed by applying a bending moment while the tubing was under pressure.

Tubing which had been dented and straightened showed essentially complete recovery of its original hydraulic characteristics.

Bending strength of badly dented and straightened tubing was restored to an average of 95 per cent of the original strength within the proportional limit. Bending-strength tests showed that these repaired sections would not stand as much plastic bending as the undamaged sections without buckling.

While it does not appear practical for the average farmer to own and operate his own straightening equipment, it should be practical for someone to offer this service on a custom basis. A set of plugs and a small hand pump carried on the pickup truck of an irrigation-equipment service man could possibly be used to build customer goodwill besides netting a fair wage from the fee charged.

Consumptive-Use Requirements for Water

Harry F. Blaney
Member ASAE

BEFORE the available water resources and an equitable division of the use of the waters of a drainage basin in arid and semiarid regions can be satisfactorily ascertained, careful consideration must be given to the consumptive-use requirements for water in various subbasins (1, 2, 3)*. Evapotranspiration (or consumptive use) is one of the important elements in the hydrologic cycle of water movement from the time water falls on the land as rain or snow until it reaches the ocean. It includes all transpiration and evaporation losses from lands on which there is growth of vegetation of any kind, whether agricultural crops or native vegetation, plus evaporation from bare land and from water surfaces. In this paper the term "evapotranspiration" is considered synonymous with the term "consumptive use". Evapotranspiration involves problems of water supply, both surface and underground, and watershed management, as well as those of the management and general economics of irrigation and multiple-purpose projects. Data on the use of water by vegetative cover are essential in planning federal, state, and private irrigation and water-supply projects in arid and semiarid regions. The consumptive-use requirement for water has become an important factor in the arbitration of controversies regarding major stream systems such as the Rio Grande (1) and the Colorado River (2), in which the welfare of the people of valleys, cities, states, and even nations is involved.

The annual runoff from drainage basins in the United States vary widely from year to year. In eastern and central parts of the nation with humid climates the variation from place to place is less pronounced than in the western states where climates vary from extremely arid to highly humid.

The U.S. Geological Survey has estimated that 1,300,000,000 acre-feet of water is carried annually across the borders of the United States into the oceans (12). This is equivalent to an average depth of about 8 in over the entire country. Since the average annual precipitation of the United States is approximately 30 in, one notes that less than one-third of the water delivered to the surface of the country flows beyond its borders, and that some 22 in of moisture return to the atmosphere annually (12) as the result of evaporation and transpiration.

It has been estimated that the net annual evaporation and transpiration losses along water courses in the 17 western states amounts to more than 30,000,000 acre-feet or more than twice the annual flow of the Colorado River. This would be enough water to irrigate 10,000,000 acres of agricultural land in these states.

EVAPOTRANSPIRATION DATA

Data on evapotranspiration are necessary when deter-

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*Numbers in parentheses refer to the appended bibliography.

Use of Evapotranspiration Data in Determining the Available Water Supply in Drainage Basins

mining rainfall disposition, safe yields of ground-water basins, irrigation requirements, and water yields from mountain watersheds.

At various times during the past 50 years, agencies of the U.S. Department of Agriculture, the U.S. Department of Interior, and state agricultural colleges have measured evapotranspiration.

Methods used to determine consumptive use of water by native vegetation and agricultural crops under field conditions were described by the author at the annual meeting of the American Society of Agricultural Engineers in 1938 (4). Regardless of the method, the problems encountered are numerous. The source of water used by plant life, whether from precipitation alone or irrigation or ground water plus precipitation, is a factor in selecting a method. The methods most widely used in engineering and watershed investigations are: soil-moisture studies on plots; tank or lysimeter measurements; ground-water fluctuations; inflow-outflow measurements; integration; effective heat; correlation of water use, climatological data and other data, and vapor transfer. Some results of measurements of evapotranspiration of irrigated crops by soil moisture and tank studies are shown in Table 1.

In arid and semiarid areas, the water requirements of native vegetation are usually satisfied before water becomes available for other purposes. For instance, the U.S. Geological Survey has estimated that there are some 11 million acres of phreatophytes growing in the 17 western states which consume more than 16 million acre-feet of water annually. Table 2 gives the results of some typical measure-

TABLE 1. SEASONAL CONSUMPTIVE USE OF WATER BY VARIOUS IRRIGATED CROPS AS DETERMINED BY FIELD EXPERIMENTS IN SEVERAL WESTERN STATES

Location and crop	Year	Growing season or period	Consumptive use of water, in	Authority
ALFALFA				
Bonnara Ferry, Idaho	1940-47	5/5 - 9/25	24.0	Marr and Criddle
Carlsbad, New Mex.	1940	4/18-11/10	38.6	Blaney
Logan, Utah	1902-29	5/7 -10/11	25.0	Pittman and Stewart
San Fernando, Calif.	1940	4/1 -10/31	37.4	Blaney and Stockwell
COTTON				
Bakersfield, Calif.	1927-30	4/1 -10/31	29.2	Beckett and Dunshoe
Fort Stockton, Tex.	1940	4/13-11/11	28.9	Blaney and Bloodgood
Los Banos, Calif.	1932	5/1 -10/31	25.5	Adams and Veihmeyer
Mesa, Arizona	1935	4/1 -10/31	30.9	Harris and Hawkins
SMALL GRAINS				
Bonnara Ferry, Idaho	1930-47	5/5 - 8/5	17.5	Marr and Criddle
San Luis Valley, Colo.	1936	6/1 - 8/31	14.05	Blaney
Scottsbluff, Nebr.	1932-35	4/20- 7/25	14.72	Bowen
ORCHARD-ORANGES				
Arums, Calif.	1929	4/1 -10/31	21.8	Blaney and Taylor
Mesa, Arizona	1931-34	3/1 -10/31	32.4	Harris and Kinnison
ORCHARD-DECIDUOUS				
Albuquerque, N. M.	1936	5/1 - 9/30	19.5	Blaney
Wenatchee, Wash.	1940	4/15-10/22	23.0	Fortier
Ontario, Calif.	1928	4/1 - 9/30	28.4	Blaney and Taylor
POTATOES				
Bonnara Ferry, Idaho	1947	5/8 - 9/27	22.95	Marr and Criddle
Ontario, Oregon	1941-42	4/20- 8/31	17.9	Sanford and Criddle
San Luis Valley, Colo.	1936	6/1 - 9/30	19.89	Blaney
SUGAR BEETS				
Davis, Calif.	4/1 - 9/30	25.2	Veihmeyer
Logan, Utah	1902-29	4/15-10/15	25.0	Pittman and Stewart
Scottsbluff, Nebr.	1932-36	4/20-10/15	24.0	Bowen
TRUCK				
Stockton, Calif.	1925-28	5/1 - 9/30	21.4	Stout
Stockton, Calif.	1925-28	4/1 -10/31	24.6	Stout

TABLE 2. EXAMPLES OF ANNUAL EVAPOTRANSPIRATION BY NATIVE VEGETATION AS MEASURED BY LYCHMETERS, TANKS OR SOIL MOISTURE STUDIES IN WESTERN UNITED STATES

Location	Type of vegetation	Precipitation, in	Year	Annual evapotranspiration, in	Authority
Valley land (no high water table)					
San Bernardino, Cal.	Grass	10.75	1928-29	10.0	Blaney-Taylor (5)
Ontario, Calif.	Grass	14.06	1927-28	14.0	Blaney-Taylor (5)
Anaheim, Calif.	Grass	12.58	1927-28	12.6	Blaney-Taylor (5)
Cucamonga, Calif.	Grass	13.54	1928-29	13.5	Blaney-Taylor (5)
Cucamonga, Calif.	Grass	17.25	1929-30	15.0	Blaney-Taylor (5)
El Rio, Calif.	Grass	16.55	1931-32	15.1	Blaney (6)
San Bernardino, Cal.	Brush	20.90	1929-30	19.1	Blaney-Taylor (5)
Mussey, Calif.	Brush	18.19	1928-29	17.6	Blaney-Taylor (5)
Claremont, Calif.	Brush	16.35	1929-30	16.3	Blaney-Taylor (5)
Valley land (high water table)					
Santa Ana, Calif.	Salt grass	12.29	1931-32	40.8(a)	Blaney-Young (6)
Santa Ana, Calif.	Salt grass	12.29	1931-32	35.3(b)	Blaney-Young (6)
Santa Ana, Calif.	Salt grass	12.29	1931-32	13.4(c)	Blaney-Young (6)
Los Gringos, N. M.	Salt grass	7.03	1927-28	22.7	Elder (1)
Mesilla Valley, N.M.	Salt grass	1936-37	39.8(d)	Blaney (1)
Carlsbad, N. M.	Sacaton	12.30	1940	44.8(e)	Blaney-Morin (3)
Carlsbad, N. M.	Salt cedar	12.30	1940	57.3	Blaney-Morin (3)
Safford, Ariz.	Salt cedar	6.00	1944	86.4	Getweed-Robinson (13)
Safford, Ariz.	Cottonwood	6.00	1944	72.0	Getweed-Robinson (13)
San Luis Rey, Calif.	Cottonwood	14.00	1941-43	62.5	Muckel-Blaney (7)
Victorville, Calif.	Tules	9.02	1931-32	78.4	Blaney-Taylor (6)
Mountain watersheds (no water table)					
Sierra Ancha, Ariz.	Grassland	11.80	1938-39	11.1	Rich (7)
Sierra Ancha, Ariz.	Grassland	35.35	1940-41	26.3	Rich (7)
Sierra Ancha, Ariz.	Grasses	26.33	1936	24.3	Rich (7)
San Dimas, Calif.	Chaparral	45.10	1942-43	20.4	Rowe-Colman (16)
San Dimas, Calif.	Chamise	45.10	1942-43	22.6	Rowe-Colman (16)
North Fork, Calif.	Chaparral	24.60	1938-39	16.2	Rowe-Colman (16)
North Fork, Calif.	Chaparral	40.80	1938-39	17.8	Rowe-Colman (16)

(a) Depth to water table - 12 in (c) Depth to water table - 48 in
(b) Depth to water table - 24 in (d) Depth to water table - 14 in
(e) Depth to water table - 36 in

ments of annual evapotranspiration used by native vegetation in valley and mountain areas in western states.

ESTIMATING EVAPOTRANSPIRATION

In water supply and irrigation investigations, engineers and hydrologists are called upon to make, within a limited time, estimates of probable past, present, and future evaporation and evapotranspiration losses in drainage basins. Sometimes few long-period hydrologic records, except climatological data, are available (1, 3). The results of research on the relationship of evapotranspiration to climate and other factors provide the practicing engineer with the basic data and methods required to estimate consumptive use in utilization of water investigations (3).

Briefly, the procedure developed by Blaney and Criddle (10), is to correlate existing consumptive-use data with monthly temperature, percent of daytime hours and precipitation for both the frost-free period or irrigation season, and for the entire year. The coefficients so developed for different crops are used to transfer consumptive-use data from one section to other areas where only climatological data are available.

Neglecting the unmeasured factors, consumptive use varies with the temperature, daytime hours, and available moisture (precipitation, irrigation and/or ground water). By multiplying the mean monthly temperature, t , by the monthly percent of daytime hours of the year, p , a monthly consumptive-use factor, f , is obtained. Then it is assumed

TABLE 3. NORMAL CONSUMPTIVE-USE COEFFICIENTS FOR THE MORE IMPORTANT IRRIGATED CROPS AND NATURAL VEGETATION OF THE WEST (10)

Crop	Length of growing season or period	Consumptive use coefficient (K)
Irrigated land		
Alfalfa	Frost-free	0.80 to 0.85
Beans	3 months	0.60 to 0.70
Corn	4 months	0.75 to 0.85
Cotton	7 months	0.60 to 0.65
Citrus orchard	7 months	0.50 to 0.65
Deciduous orchard	Frost-free	0.60 to 0.70
Flax	7 to 8 months	0.80
Pasture, grass	Frost-free	0.75
Potatoes	3 months	0.65 to 0.75
Small grains	3 months	0.75 to 0.85
Sorghum	4 to 5 months	0.70
Sugar beets	5 months	0.65 to 0.75
Natural vegetation (b)		
Very dense	Frost-free	1.30
Dense	Frost-free	1.20
Medium	Frost-free	1.00
Light	Frost-free	0.80

(a) The lower values of K are for coastal areas, the higher values for areas with an arid climate.
(b) Ample moisture available from ground-water table.

that the consumptive use varies directly as this factor, when an ample water supply is available. Expressed mathematically,

$$U = KF = \text{sum of } kf$$

where U = consumptive use of crop (or evapotranspiration) in inches for any period

F = sum of the monthly consumptive use factors for the period (sum of the products of mean monthly temperature and monthly percent of annual daytime hours), $t \times p$

K = empirical coefficient (annual or irrigation season)

t = mean monthly temperature in degrees Fahrenheit

p = monthly percent of daytime hours of the year

$f = (t \times p) / 100$ = monthly consumptive use factor

k = monthly coefficient

$u = kf$ = monthly consumptive use in inches.

By knowing the consumptive-use requirement of water by a particular crop in some locality, an estimate of the use by the same crop in some other area may be made by application of the formula, $U = KF$ (7, 10).

The consumptive-use coefficients, K , for the more important irrigated crops grown under normal conditions in the West and natural vegetation are shown in Table 3. These

TABLE 4. MONTHLY PERCENT OF DAYTIME HOURS OF THE YEAR FOR LATITUDES 24 TO 50 DEGREES NORTH OF THE EQUATOR (a)

Month	Latitudes in degrees north of equator															
	24	26	28	30	32	34	36	38	40	42	44	46	48	50		
January	7.58	7.49	7.40	7.30	7.20	7.10	6.99	6.87	6.76	6.62	6.49	6.33	6.17	5.98		
February	7.17	7.12	7.07	7.03	6.97	6.91	6.86	6.79	6.73	6.65	6.58	6.50	6.42	6.32		
March	8.40	8.40	8.39	8.38	8.37	8.36	8.35	8.34	8.33	8.31	8.30	8.29	8.27	8.25		
April	8.60	8.64	8.68	8.72	8.75	8.80	8.85	8.90	8.95	9.00	9.05	9.12	9.18	9.25		
May	9.30	9.38	9.46	9.53	9.63	9.72	9.81	9.92	10.02	10.14	10.26	10.39	10.53	10.69		
June	9.20	9.30	9.38	9.49	9.60	9.70	9.83	9.95	10.08	10.21	10.38	10.54	10.71	10.93		
July	9.41	9.49	9.58	9.67	9.77	9.88	9.99	10.10	10.22	10.35	10.49	10.64	10.80	10.99		
August	9.05	9.10	9.16	9.22	9.28	9.33	9.40	9.47	9.54	9.62	9.70	9.79	9.89	10.00		
September	8.31	8.31	8.32	8.34	8.34	8.36	8.36	8.36	8.36	8.40	8.41	8.42	8.44	8.44		
October	8.09	8.06	8.02	7.99	7.93	7.90	7.85	7.80	7.75	7.70	7.63	7.58	7.51	7.43		
November	7.43	7.36	7.27	7.19	7.11	7.02	6.92	6.82	6.72	6.62	6.49	6.36	6.22	6.07		
December	7.46	7.35	7.27	7.14	7.05	6.92	6.79	6.66	6.52	6.38	6.22	6.04	5.86	5.65		
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00		

(a) Computed from Sunshine Tables, U. S. Weather Bureau Bulletin No. 805, edition of 1905.

TABLE 5. AN EXAMPLE OF DETAILED CALCULATIONS OF RAINFALL PENETRATION IN INCHES AT STATION 83, 1931-32 (a)

Factors	Oct	Nov	Dec	Jan	Feb	Mar	Total	Crop
Rainfall	...	2.6	7.8	1.7	5.2	0.0		Citrus, clean,
Runoff	...	0.0	0.0	0.0	0.0	0.0		cultivated, irri-
Transpiration	...	1.0	1.0	1.0	1.0	1.0		gated usual prac-
Evaporation	...	1.0	1.9	1.4	1.5	0.0		tice.
Difference	...	0.6	4.9	-0.7	2.7	-1.0		
Soil-moisture deficiency	2.5	1.9	0.0	0.7	0.0	1.0		
Penetration	...	1.0	...	2.0	...	5.0		
Rainfall	...	2.6	7.8	1.7	5.2	0.0		Citrus, clean
Runoff	...	0.0	0.0	0.0	0.0	0.0		cultivated, irri-
Transpiration	...	1.0	1.0	1.0	1.0	1.0		gated just prior
Evaporation	...	1.0	1.9	1.4	1.5	0.0		to rainy season
Difference	...	0.6	4.9	-0.7	2.7	-1.0		
Soil-moisture deficiency	0.5	0.0	0.0	0.7	0.0	1.0		
Penetration	...	0.1	4.9	...	2.0	...	7.0	
Rainfall	...	2.6	7.8	1.7	5.2	0.0		Deciduous, clean
Runoff	...	0.0	0.0	0.0	0.0	0.0		cultivated.
Transpiration	...	0.0	0.0	0.0	0.0	0.0		
Evaporation	...	1.0	1.9	1.4	1.5	0.0		
Difference	...	1.6	5.9	0.3	3.7	0.0		
Soil-moisture deficiency	10.0	8.4	2.5	2.2	0.0	0.0		
Penetration	1.5	...	1.5	
Rainfall	...	2.6	7.8	1.7	5.2	0.0		Deciduous, cover
Runoff	...	0.0	0.0	0.0	0.0	0.0		cropped.
Transpiration	...	0.0	0.0	1.0	1.0	1.0		
Evaporation	...	1.0	1.9	1.4	1.5	0.0		
Difference	...	1.6	5.9	-0.7	2.7	-1.0		
Soil-moisture deficiency	10.0	8.4	2.5	3.2	0.5	1.5		
Penetration	0.0	

(a) Total seasonal rainfall, 11.54 in. No winter irrigation.

coefficients were developed from actual measurements of consumptive use in tank and soil moisture field studies and inflow-outflow measurements made throughout the West over a period of years. Monthly percentage of daytime hours for the year are shown in Table 4.

Fig. 1 is a nomograph developed for estimating monthly rates of water use for locations where mean monthly temperatures are available and the latitude of the area is known.

RAINFALL AND IRRIGATION PENETRATION TO GROUND WATER

Evapotranspiration data are useful in determining the contributions of rainfall on the valley floors and return from irrigation to the ground water in drainage basins. In some areas these items are very important when determining the available water supply of a basin.

Rainfall Contribution

Rainfall is disposed of in four parts: (a) surface runoff, (b) evaporation, (c) transpiration, and (d) percolation. Only the last part passes to the ground-water supply. Under ordinary topographic and soil conditions, surface runoff will occur when the precipitation is of sufficient intensity. A part of the surface runoff from valley floors may be termed

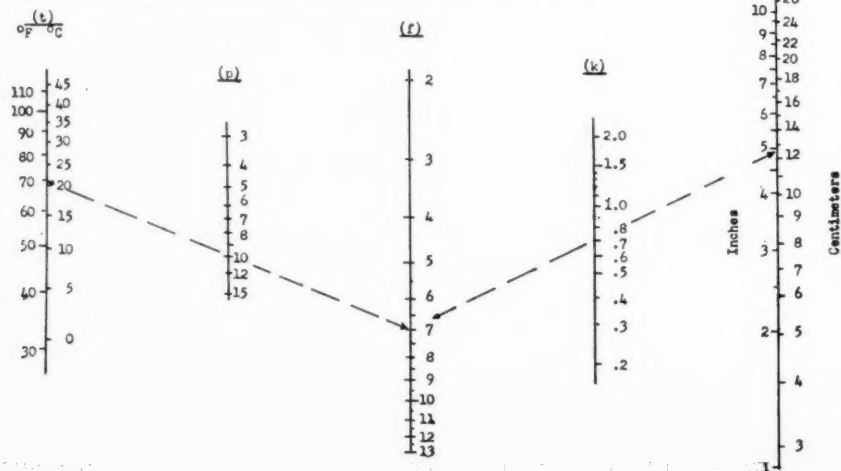
Fig. 1 Nomograph for solution of the consumptive-use formula, $u = kf$ 

TABLE 6. ESTIMATED RAINFALL PENETRATION BELOW ROOT ZONE IN AGRI-CULTURE, VENTURA COUNTY, CALIFORNIA

Basin	1927-28	1928-29	1929-30	1930-31	1931-32
Piru	860	1,170	1,750	1,700	5,050
Fillmore	890	2,650	2,550	2,950	8,270
Santa Paula	320	680	950	900	4,770
Montalvo, North	150	340	470	520	1,740
Montalvo, South	290	720	900	850	3,310
Subtotal	2,510	5,560	6,620	6,920	23,140
West Las Posas	130	400	680	470	1,940
Pleasant Valley	80	520	520	530	3,430
Las Posas (Moorpark)	320	710	790	780	4,980
Conejo (Santa Rosa)	180	240	190	370	1,460
Simi	370	460	320	530	1,600
Subtotal	1,080	2,330	2,440	2,730	12,410
Ojai Valley	120	50	310	200	2,120
Ventura River	620	710	370	710	3,900
Ventura Avenue	220	240	250	310	1,600
Subtotal	960	1,000	1,130	1,220	7,620
Grand total	4,550	8,890	10,190	10,870	43,170

local as it flows directly into depressions and then percolates into the ground without reaching the main surface streams. That portion of the precipitation retained temporarily in the top layer of the soil or intercepted by plants is returned to the atmosphere by evaporation. Of the water which percolates into the ground, a portion is stored in the soil within the root zone and subsequently is transpired by plants, while the remainder penetrates below the root zone and joins the ground water.

The amount of rainfall penetration to the ground water has been determined in several basins in California indirectly from evaporation and transpiration measurements when values have been established for other factors entering into the disposition of rainfall (5). Tables 5 and 6 illustrate the results of such study in Ventura County by the author in cooperation with the state engineer of California (8).

Irrigation and Rainfall Penetration

Evapotranspiration data have been used in several irrigated valleys of the west to estimate return waters from irrigation as well as penetration of rainfall to the underground reservoirs. For example, after unit values of consumptive use were determined for irrigated, dry farm, native vegetation and incidental areas in the Ventura County Flood Control District in California in 1952-53, the mean annual deep penetration was calculated (15).

Somewhat similar studies were made to determine the available ground-water supply in the Los Angeles West Coast Basin in connection with the adjudication of the water rights of this basin by the California Division of Water Resources and to determine sources of water causing high water table and drainage problems in the San Fernando Valley in cooperation with the city engineer of Los Angeles.

WATER REQUIREMENTS AND STREAM-FLOW DEPLETION

The major problem in many of our western interstate drainage basins is the division of water supply between states and subbasins

within the states, and, in some instances between the United States and border nations. Federal agencies in cooperation with state engineers have measured evaporation and evapotranspiration for the purpose of determining consumptive-water requirements and stream-flow depletion resulting from diversions of stream flow for irrigation, domestic, and industrial purposes. The author has conducted some of these investigations.

The following studies illustrate the use of evapotranspiration data:

Rio Grande-Colorado, New Mexico and Texas (1)

The investigation, Consumptive Use of Water in the Upper Rio Grande Basin, comprising some 34,000 square miles in Colorado, New Mexico and Texas, was required as part of the development of facts concerning water requirements and stream-flow depletion as a basis of an interstate compact to provide the equitable apportionment of Rio Grande waters among the three states. A total of some 2,000,000 acres of water-consuming areas was mapped under classification of irrigated, native vegetation and incidental areas and rates of evapotranspiration determined by field studies were applied to these acreages to estimate total consumptive use. These results when adjusted for appropriate values of precipitation were used to determine stream-flow depletion in each subbasin. For the 954,000 acres irrigated in the basin in 1936, the stream-flow depletion was found to be 1,376,000 acre-feet whereas the use by native vegetation and other nonbeneficial consumption as an incident to that irrigation was estimated to be 1,478,000 acre-feet. In other words, about one-half of the stream-flow depletion resulted from nonbeneficial evapotranspiration losses.

Pecos River Basin, New Mexico, Texas (3)

In the Pecos River investigation, consisting of some 35,000 square miles in New Mexico and Texas, consumptive-water requirements and stream-flow depletions were determined in a somewhat similar way to those of the Rio Grande. More than 764,000 acres of water-consuming areas were mapped in 1940. The areas of native vegetation totaling more than 454,000 acres was shown to represent a stream-flow depletion of 273,000 acre-feet or about 77 percent of the depletion by the 210,000 acres irrigated in 1940.

From long-period records of evaporation, temperature, and humidity in New Mexico and Texas, together with consumptive-use measurements at Carlsbad, N.M., empirical formulas were developed for computing evaporation and consumptive use when temperature and humidity data are available (3). Consideration of these results and the factors involved is shown in the expression

$$u = ktp(114 - b) = kc$$

in which u is the monthly consumptive use (or evaporation) in inches, k is the monthly empirical coefficients, t is the mean monthly temperature (degree-Fahrenheit), p is the monthly percentage of daytime hours of the year, b is the average monthly humidity, and $c = tp(114 - b)$ is the monthly use index (climatic factor). The formula for annual consumptive use (or evaporation) in inches is

$$U = K_a C = K_w c_w + k_s c_s$$

in which K_a is the empirical coefficient for the entire year, C is the use index for entire year, k_w is the empirical coefficient

for winter period, k_s is the empirical coefficient for growing season or frost-free period, c_w is the use index for winter season, and c_s is the use index for growing season or frost-free period. The values of k_w and k_s may be computed from observed values of consumptive use, temperature, and humidity by the relation $k = u/c$. These formulas are useful in estimating evaporation and evapotranspiration losses when no local data are available on water consumption.

Colorado River Basin (Arizona, California, Colorado, New Mexico, Nevada, Utah and Wyoming)

In 1948, at the request of the Upper Colorado River Compact Commission, representing the states of Arizona, Colorado, New Mexico, Utah, and Wyoming, and the U.S. Bureau of Reclamation, a study was made of water consumption by agricultural crops and native vegetation in the basin. The consumptive-water requirements, stream-flow depletion, and available water supply in each state and subbasin had to be known before an equitable division of the use of the waters of the Upper Colorado River Basin could be ascertained. After a field inspection of the areas in the basin with representatives of the engineering advisory committee of the Commission, and numerous conferences with local leaders and water users in each area, a report on consumptive use of water rates for 56 areas in the Upper Colorado River Basin was submitted by Blaney and Criddle (9).

Because of the limited measurements of consumptive use in the Upper Colorado River Basin, estimates of unit use by the various agricultural crops and native vegetation in this basin have been based largely on studies in other areas of the West. The findings in these studies were transferred to the Upper Colorado River Basin by the method developed by Blaney and Criddle. (10). In the Lower Basin, measurements of water use are available in a few areas in Arizona.

During 1951-52, Blaney and Harris made a study of water-consumption rates by agricultural crops and native vegetation in various irrigated areas of Arizona, California, Nevada, New Mexico, and Utah in the Lower Colorado River Basin, at the request of the U.S. Bureau of Reclamation (11). Estimates of unit consumptive use by various agricultural crops are based primarily on measurements made on use of water in the Salt River Valley, Arizona, by the Division of Irrigation and Water Conservation in cooperation with the University of Arizona. Estimates of water consumption by native vegetation are based for the most part on observations made by the U.S. Geological Survey in Safford Valley, Ariz. These data were transferred to areas of the Lower Colorado River Basin through relationships established empirically between measured consumptive use and climatological data. These data were employed by the Bureau of Reclamation to determine the stream-flow depletion in each subbasin of the Lower Colorado River Basin.

Columbia River Basin above The Dalles, Ore. (17)

A report made by the U.S. Geological Survey in 1953 presents data gathered from many sources on the irrigated area in the United States portion of the Columbia River Basin above The Dalles, Ore., where irrigation is necessary for sustained crop production. Values of net consumptive use of water were determined or estimated for various tributary basins and compared to available experimental data. These values were then used to compute the average depletion which could be directly attributed to irrigation. This

(Continued on page 880)

Lightweight Sprayer for Experimental Plots

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THE research worker conducting weed-control investigations is faced with the usual problems of experimental technique in addition to those peculiar to the herbicidal field, one of the most important being the method of application of sprays to small plots. The knapsack sprayer, once widely used, does not closely simulate actual field-spray applications because of the inability of the operator to accurately gage his walking speed. Because of this variable, most knapsack operators apply a certain quantity of solution on a plot of given size, often necessitating double or triple coverage of the soil or vegetation using increased amounts of solvent. Since lower volumes are generally used for field spraying, results may be affected by the use of larger volumes. Tractor spray rigs, in addition to being cumbersome to transport, often necessitate a larger experimental area.

Several different types of experimental sprayers have been developed for plot work (1, 2, 3, 4, 5).^{*} One of the most efficient, in the opinion of the authors, is the one described by Shaw (3) in 1950. The frame work of the sprayer was constructed of 1¼-in angle iron. Regular knapsack spray tank units were used to hold the spray solutions. Two booms, quick-action shutoff valves, a pressure regulator, a speedometer, and compressed-air storage tanks were other features incorporated into the sprayer. The principal variables involved in field application of herbicides—speed, pressure, volume, and coverage—are effectively controlled by use of this type sprayer. One of the limiting factors was the weight of the sprayer, 175 pounds. This weight, while not excessive on pasture land or firm field soil, could be burdensome on soft uncompacted land. Shaw and Swanson (4)

later described a modified sprayer which was lighter than the original model.

The sprayer developed at the Georgia Experiment Station incorporates the basic elements of the field-plot unit described by Shaw. However, the details of construction are different.

Adaptability of the Georgia Sprayer

The sprayer described here was used under various soil and moisture conditions during the spring of 1954 at seven locations in Georgia. Because of its light weight (105 lb) the sprayer worked satisfactorily except on very wet clay or exceptionally cloddy seedbeds. These particular conditions reduce maneuverability and also the accuracy of the speedometer reading. On sandy soils or soft seedbeds, an additional operator is desirable. The time required for a four replication test, including flushing the sprayer and refilling the compressed-air storage tank, has consistently averaged less than two minutes per 1/200-acre plot. The storage tank will supply enough air for applying 10 one-gallon entries, including the air used for flushing. This number will be reduced when wettable powders requiring more agitation are applied.

The construction of the boom facilitates changing the method of spray applications. Complete readjustment of the nozzles to any desired spacing or height requires less than five minutes. This is useful for pre-emergence applications since either complete coverage or definite band widths of variable spacings may be used. Adjustments required for directed post emergence spraying are much more quickly and easily made than with an ordinary boom.

Two men can easily lift the sprayer into a pickup truck bed for transporting. All of the equipment needed for spraying including the sprayer, jugs of solution, air compressor, tools, and miscellaneous items, are transported in the truck.

Although designed primarily as an experimental plot sprayer, it is believed that the sprayer might be adapted for other uses, especially for application of chemicals to horticultural crops on limited acreages.

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^{*}Numbers in parentheses refer to the appended bibliography.

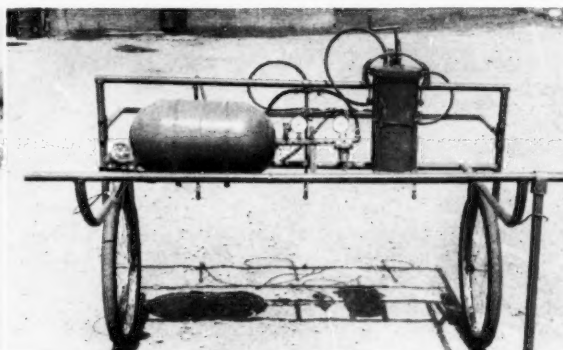
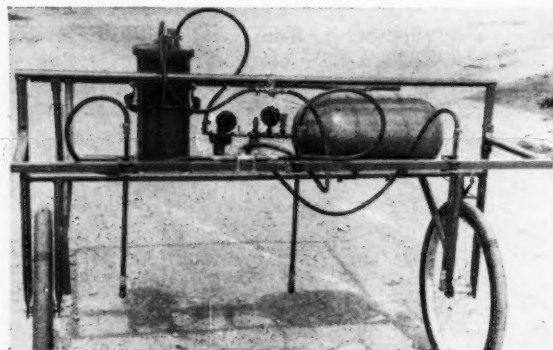


Fig. 1 (Left) Front view of Georgia plot sprayer showing construction details of manifold, boom, drop pipes, and wheel assembly •
Fig. 2 (Right) Rear view of plot sprayer showing construction details of frame, speedometer, pressure-regulation system, solution tank, and kickstand

General Construction

The frame of the sprayer is constructed of $1\frac{3}{16}$ -in., 16-gage steel tubing. A wheel spacing of 60 in is most adaptable for the various row spacings used in Georgia. This distance can be varied to meet individual requirements. A war-surplus oxygen tank for compressed-air storage is mounted slightly to the rear of the center line of the wheels as shown in Figs. 1 and 2. The solution tank, constructed of 18-gage galvanized iron and also mounted to the rear of the wheel center line, is made to receive a one-gallon glass vinegar or similar type jug. The use of this type instead of fixed-spray containers facilitates cleaning the spray system. The lid of the solution tank is fastened by means of a screw crank and bale arrangement as shown in Fig. 2. It is necessary that the lid be airtight as the pressure is contained by this tank and not by the jug. Since these tanks are mounted to the rear of the wheel centers the operator must lift upward; this action helps in maintaining a steady, even gait.

In order to keep the over-all weight to a minimum, a light-weight boom was made from a 1-in-square 22-gage steel tube (Fig. 1). The boom has two mounting positions located 12 in apart vertically. Any desired lateral or vertical spacing of the nozzles may be obtained by means of the U-bolt clamping device which secures the $\frac{1}{4}$ -in by 18-in galvanized iron drop pipes. By supplying the nozzles with the solution through a series of tees (manifold) and hoses, greater adaptability is obtained than with the regular boom arrangement, since any number of nozzles may be used up to the capacity of the line. A quick-action, spring-loaded, cut-off valve mounted close to the manifold is controlled by a lever on the push bar.

A bicycle speedometer is mounted in view of the operator and driven from one of the bicycle wheels. It has a 10 to 1 reduction; thus a reading on the dial of 10 mph indicates that the sprayer is traveling 1 mph.

Pressure Source and Regulation

The pressure tank is equipped with a snap-on fitting for filling with air, a pressure gage and a relief valve set at 145

psi. The air pressure for filling the tank in the field is supplied by a gasoline-engine-driven portable air compressor. The line from the pressure tank to the solution tank is equipped with a cutoff valve to prevent loss of air pressure when solutions are changed. A diaphragm-type pressure regulator is installed between this cutoff and the pressure gage. From the pressure gage, the line passes into the solution tank by means of a $\frac{3}{16}$ -in stainless steel tube soldered to the lid of the tank and long enough to reach the bottom of the jug. This tube and a similar one leading to the boom are in the center of the lid and fit inside the gallon jug containing the spray solution. Generally the spray solutions receive enough agitation by the incoming air while spraying. When more agitation is required, it may be obtained by partially opening the petcock located in the tank lid. This petcock is also used to release pressure after spraying.

Suggestions for Improvement

In areas where very soft soils are prevalent or where only one man is available for spraying, the use of aluminum tubing for the sprayer framework, reducing the weight to an estimated 70 lb, might be desirable.

For corrosive materials, stainless steel drop pipes and fittings might be more desirable than galvanized iron.

A clamp-type fastening for the lid of the solution tank would probably be more satisfactory than the screw crank and bale arrangement as a uniform seal is difficult to obtain unless the bale is heavily reinforced to prevent gradual bending.

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Once-Over Tillage Idea Applied to Pineapple Production in Hawaii

To keep production costs of raising pineapples to a minimum, the California Packing Corp. is constantly seeking ways and means to develop new machinery to do the production job better and more efficiently. The latest development is the mulching machine shown in these pictures which is built around a Caterpillar D8 track-type tractor. After a stump cutter has thoroughly chopped up the old pineapple plants in a field, the field is ready for the machine shown, and it completes all tillage operations in one pass over the field, to make it ready for planting a new crop of pineapples. On the front of the tractor is mounted a trash rake which is powered with the

tractor's hydraulic unit to clear to one side the mat of trash left on the field by the stump cutter. Two power-take-off-driven rotary tillers, mounted on the rear, work the soil to a depth of 14 in. Fumigating and fertilizing equipment make up the rest of the 10 tons of farming tools that have been attached to the framework of this outfit, and a rear-mounted float completes the operation, smoothing the ground for planting. All told, the huge mulching machine weighs close to 30 tons. It travels only in low gear when preparing a field for planting pineapples and its capacity is approximately one acre per hour.

Erosion Control Problems of the Humid Region

L. B. Nelson

Research Presently Under Way, as Well as Further Studies Needed, to Develop Better Conservation Practices

THE purpose of this paper is to present a fairly broad picture of the research that is under way in erosion control in the humid region. Also I will point out some further needs in the research program, and discuss a couple of unrelated items.

Research in erosion control does not fall definitely within any single subject-matter field. As a matter of fact, it is so closely related to all other soil and water conservation work that we cannot really deal with it as a separate subject. However, for the present purpose I will confine my remarks largely to the fields of agricultural engineering and agronomy with some reference to economics. Our best erosion control practices develop through integrated effort from these three fields plus several others. This reasoning is behind the present organization of the land-use and management research program of the USDA.

In the erosion control research of the USDA Agricultural Research Service, the aim is to identify the problem first, to analyze it, and then to establish a team to deal with its component parts. In this team, the agricultural engineer has the training and capability to deal with problems of machinery and tillage, construction of terraces, waterways, ponds and dams, surface and subsurface drainage, ditches, and the like. Similarly, the agronomist is best trained to deal with crop and soil-management factors including fertilizers, crop rotations, specialized soil physical problems, and microbiology. The economist, on the other hand, is in the best position to study and evaluate the economic returns that are possible from various practices and combinations of practices and to tell us whether or not these are feasible from the farmer's standpoint. To be sure, there is some overlapping in fringe areas.

Mulch tillage is one of the most important erosion control practices and one where considerably more research is needed. Research has shown that leaving crop residues in the surface two or three inches of soil is one of the most effective means we have for reducing runoff and erosion in row crops. Unfortunately mulch tillage frequently reduces yields. This reduction appears most severe during normal and wet seasons and least during seasons of low rainfall. Reductions in yield must be overcome before the practice will receive widespread adoption by farmers. We and our cooperators in the states are placing major emphasis on finding out what causes the yield reductions. Offhand it appears that the yield reductions are intimately related to a tie-up of plant nutrients, particularly nitrogen, by microorganisms, and to poor aeration in the layer below the mulch. Undoubtedly other factors may be involved.

The application of surface mulches for erosion control

Paper presented at the 47th annual meeting of the American Society of Agricultural Engineers at Minneapolis, Minn., June, 1954, on a program arranged by the Soil and Water Division.

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looks most promising for certain humid-region soils. In Ohio, application of 1½ to 2 tons of straw or 7 to 8 tons of manure per acre produced corn yield increases ranging from 7 to 14 bu per acre. This practice permits wet soils to dry out before planting, protects the soil against erosion losses, increases water infiltration during high-intensity summer storms, and apparently does not reduce yields. However, delayed mulching does not afford soil protection early in the season.

Lister planting of corn between terrace intervals has given effective erosion control on the steep, highly erosive loess soils of western Iowa. This practice has reduced soil loss 65 percent and cut runoff 42 percent, permitting use of wider-spaced terraces and rotations with a higher percentage of corn. It would seem that this practice should be used more widely. At least evaluation should be made over more steep-land soils.

We still have a big problem with terraces. Terraces aren't gaining in popularity. Our original specifications may have been too rigid for some conditions. A good many terraces were built too close together and with greater capacity than necessary. Where this has happened, costs are too high and the terraces are not compatible with modern machinery. Perhaps it is time to find out more exactly what is needed in light of modern farm practices and equipment. Parallel terraces offer considerable promise. Elimination of point rows by bringing in other improved erosion control practices along with less rigid contouring may offer a possible solution. However, we most certainly don't want to take unnecessary chances with erosion.

The design, efficiency and maintenance of waterways and terrace outlets is receiving considerable research attention. Studies include not only the engineering design but also vegetative cover and methods of establishment. Major emphasis is placed on low-cost procedures.

Land smoothing to eliminate small depressions which will eliminate water ponding during wet periods and improve surface drainage is receiving attention in several states.

Wide-row spacing of corn with interplantings of grasses and legumes appears to offer promise for corn production on sloping lands. At the same time, it offers a means of establishing seedlings without the use of less profitable small-grain nurse crops. Corn yields in Iowa last year at six locations averaged 94 bu per acre in 40-in rows, and 73 bu in 80-in rows, a decrease of 22 percent. However, the 80-in rows permitted interseeding with grass legume mixtures at the last cultivation. Where drought conditions were not severe, satisfactory stands of seedlings were obtained.

Considerable research needs to be done on corn interplanting. Attention needs to be given to the competition between the two crops for moisture and nutrients and ways in which to handle the forage. In Illinois, for example, harvesting management of the intercrop greatly influenced the corn yields. Corn yields on conventionally farmed plots were higher than where a 15-in strip of grass-legume mixture was allowed to grow between each row. Likewise the

plots with the 15-in strips of grass produced higher corn yields than plots where a 60-in strip was allowed to grow between every two corn rows (40 by 80 in row spacings). Management of the intercrop also influenced corn yields. Frequent clipping and using the clippings for mulch in the corn rows improved yields.

It seems absolutely necessary that we improve procedures and equations for estimating soil loss under different farming practices on different soils and topographies. To accomplish this we need to know a lot more about the behavior of various soil-erosion factors under a wide range of soils and conditions. With an adequate mathematical guide, conservation specialists can tailor their recommendations more exactly to the conditions encountered on the individual farm.

In this connection, we and our state cooperators are making a national summary of all the old plot and watershed runoff records and weather data that have been collected. This is a tremendous task but we will eventually have the data on IBM punch cards. Once this is done, we will be on a much sounder basis for developing erosion equations. Similarly, we will have a pretty good picture of the characteristics of storms in various areas and their relation to runoff and erosion.

In the matter of deep tillage, while this isn't strictly an erosion-control practice, it is related and also has broad implications in the soil and water field. There appears to be no question that deep tillage is a big help in breaking "traffic" pans. Soil compaction from machinery traffic is a serious problem in New Jersey, Mississippi, Louisiana and elsewhere. Deep tillage plus lessening of machine traffic and introduction of grasses and legumes appears to overcome many of our traffic pans. We need to know more about the properties of soils in which such pans develop. Also, what are the specific soil-air relations, moisture movement, and other properties associated with the pans? Once we know these, we can widen the applicability of existing data.

The problem of deep tillage or deepening of the root zone on clay pan and normal soils is entirely another problem. We don't have the answer. It would appear only logical that deepening the root zone through tillage and the deep placement of lime and fertilizers should produce marked increases in crop yields. However, existing data in the eastern United States fails to confirm this. We and our state cooperators are initiating a series of carefully controlled experiments to see if there is any real advantage. If under ideal conditions we can't improve yields in this manner, then the subject would appear closed. On the other hand, if yields can be improved, then we will want to work closely with machinery engineers in developing machines and practices.

Research is also being conducted into the following phases of erosion control:

- Rebuilding and utilizing severely eroded lands
- Improving cropping systems including cover crops and rotations
- Times and methods for establishing pastures and forage crops
- Relation of irrigation to erosion hazard
- Strip cropping and contour farming
- Chemical and mechanical pasture renovation

- Improvement of soil structure
- Compaction of pasture soils by livestock
- Removal of excess water through surface and subsurface drainage.

So far we have dealt in individual erosion control practices; following is a proposed additional research step for your consideration: To date most of us are willing to move on when we have answered a particular problem to our satisfaction. But are we ready to pass our solution on to the farmer? In industry, the basic principles of a new process are worked out in the laboratory. However, before a new plant is constructed, pilot plants are first built for the purpose of ironing out production "bugs" and determining the economic feasibility of the process. In agriculture, on the other hand, we expect the farmer to conduct his own pilot research. We hand him numerous "test tube" practices and expect him to put them together into a smoothly functioning and economically sound farming system. Actually it is probably as big a research job to integrate and adjust various practices into a profitable system of farming as it was to develop the individual practices. To integrate practices into a farming system requires not only the attention of the research technicians but also of the economist. It would seem that we should give more thought toward achieving this final step.

Another matter for your consideration deals with integration of machinery and soil and water conservation research. Just what are the functions of the two groups in machinery development and how can we obtain closer integration? It seems to me that the soil and water folks should first determine what is required in the way of soil and fertilizer manipulation, get together with the engineer who will develop the machine, and then both work together in determining and improving its range of applicability for various soils, topographies, and farming systems. Frankly I believe we have a tendency to reverse this procedure. As a result, none of us is happy with the final product. However, this reversal of procedure isn't the fault of the machinery engineer alone. We on the other side of the fence haven't set down the necessary specifications of what the machine should accomplish.

In closing, please permit me to present a plea for better trained soil and water conservation engineers. As pointed out by Harry B. Walker in an address* last December, a real need exists in research for men of academic and scientific competency. In soil and water, we must have engineers of superior ability who are trained to think quantitatively and can subject problems to research procedure. Too many of the young engineers applying for positions with us appear to be trained for service types of work rather than research.

I would like to urge that more men be trained specifically as soil and water research engineers with a sound foundation in the following: biometry and experimental design, mathematics and physics, hydrology, soil and water conservation engineering, soil physics, plant physiology, climatology, drainage, and irrigation.

*Harry B. Walker. Balancing agricultural engineering research. AGRICULTURAL ENGINEERING, vol. 35, July, 1954.

Centennial of Farm Mechanization

Carl F. Albrecht

Affiliate ASAE

THE Centennial of Farm Mechanization is a major feature of the yearlong Centennial celebration at Michigan State College in 1955. It will represent the most complete assembly of farm and home equipment, demonstrations, and personnel dealing with the engineering phases of agriculture ever brought together in this country. The exhibits, demonstrations, and pageants will be shown from August 15 through August 20. They will be in a professionally designed setting but with scientists, technicians, extension specialists, and educators present to assist in telling the story of engineering in agriculture to a quarter million visitors.

The objectives of this exposition are to recognize the accomplishments of the farmer, industry, and education; to salute the land-grant college system of education; to honor individuals and organizations who have contributed greatly to farm mechanization and to provide a means of measuring our accomplishments and charting our course for the future. The exposition is designed to give inspiration to young and old to carry forward toward a still better life, and to provide, in one large exposition, a place where people from all over the world may come and see the agricultural machines, buildings, and equipment of the past and present and get a glimpse of the future.

The Farm Mechanization Centennial is sponsored and presented at Michigan State College by the Agricultural Engineering Department with the advice, cooperation, and assistance of other departments on campus, farm equipment manufacturers, electric power suppliers, manufacturers of farm structures and materials, and drainage and irrigation contractors and suppliers. Also assisting are public service organizations, professional engineering groups, farm organizations, farm youth groups, farm fire and safety groups, home economics groups and others.

Modern Equipment Exhibit

In the large outdoor exhibit area farm machinery companies will show the latest and most complete lines of tractors and machines. This will include those used in this country and some used in foreign lands. Combines, cotton pickers, trenching and earth-moving

machines, spray equipment, advanced-type engines and power-transmitting equipment are samples of a few of the items to be shown. New machines will be introduced to the public for the first time during the Centennial.

Special buildings adapted for farm use will be shown. These will include grain, hay and fruit storages, machinery storages and farm shops, dairy barns and silos of latest design. Bulk milk and other materials-handling equipment installations including conveyors, elevators, driers, tanks and many others will be there. Building materials of all descriptions will be exhibited.

Appliances and other electrically operated equipment of many kinds to be shown include lighting, heating, and labor-saving units. The largest and the smallest commercially made light bulb will be on display as well as a one-million-volt electron gun for cold sterilization of food products.

Also exhibited will be a complete range of irrigation sprinkler equipment from the smallest to the largest made, most types of aluminum irrigation pipe and couplings, irrigation pumps and power units of all sizes, and drainage pumps, trenching, land-leveling, and other earth-moving machines. Clay and concrete draintile of all sizes will also be on hand.

Home Exhibit

The home exhibit in the Auditorium will trace the development of the kitchen, sewing machines, vacuum cleaners, and home lighting. It will include a complete exhibit of these items in modern home equipment and a 125-ft exhibit from the Museum of Modern Art showing present and future architectural design of homes.

Education and Industrial Exhibits

The Agricultural Engineering Building will house exhibits by public service agencies and industry. A part of the story of research in agricultural engineering in the land-grant colleges and the U.S. Department of Agriculture will be told. It will include tractor tests, sugar beet mechanization, tillage and fertilizer placement. These are made possible through the cooperation of the USDA and colleges and universities. The stories of oil, rubber, chemicals, and steel will be portrayed in industrial exhibits.

Historical Exhibits

The concourse of the stadium will

MICHIGAN State College was founded February 12, 1855, as the Michigan Agricultural College, the first of its kind in the United States. The unique idea in education first put into practice in our state was extended to the entire nation within the space of a few years through the system of land-grant colleges and universities established under the Morrill Act of 1852.

This pioneer institution, now called Michigan State College and now a university serving the needs of many professions and vocations, marks its 100th birthday in 1955. But its Centennial observance is much more than the marking of 100 years off the calendar of history. It is the commemoration of an event which changed drastically the course of higher education in America; it is the commemoration of the founding of a college designed to serve people in general, rather than a special few. Here, for the first time, democracy entered into higher education in America.

The Centennial of Farm Mechanization, one of the principal events of our Centennial year's activities, will present the saga of how the mechanization of agriculture has helped to make possible our American way of life. It will demonstrate how agricultural mechanization and other applications of science to agriculture have released millions of our people from the job of producing food and fiber, and freed their efforts for the tasks of providing the goods and services which enrich our modern life.

This exposition presents the story of the past, the miracle of current developments, and inspiration for the future. It offers much of value to those engaged in agriculture, business, industry, and education; it is not for rural people alone, but for those urban dwellers as well who may not feel close to agriculture, but are heavily dependent upon it.

We welcome this opportunity to perform a special public service in the tradition of the land-grant college system. We are proud of what we have to offer visitors to this exposition, and thus to pay our tribute to the American farm family.

John A. Hannah
President, Michigan State College

The author—CARL F. ALBRECHT—is associate professor of agricultural engineering, Michigan State College, and chairman of the Centennial of Farm Mechanization Promotion and Publicity Committee.

contain tools, machines, and equipment tracing the advancement of farm mechanization up to the present. The displays will include the evolution of tillage and harvesting machinery, also farm power with engines of the past, present and future, lighting equipment and household equipment. Farm equipment companies, historical associations and museums will furnish these items.

Power and Transportation Exhibit

Nearly an acre of covered area in the Field House will be devoted to telling the story of the development of power and transportation in its service to agriculture. Railroad, automobile, truck, trailer, bus and automotive accessories companies will display new and historical equipment.

Demonstrations

Each day there will be numerous demonstrations of modern application of engineering to the farm. A modern pole building will be built. A series of demonstrations of the latest methods of grain drying and handling will be included. Tile drainage demonstrations will show the proper design and installation practice for tile drainage systems. Three identical tractors with identical loads will compete in a demonstration of the kinds of fuel to use. These are only a few of the many daily demonstrations planned for the

Centennial of Farm Mechanization; others are tilt-up silo construction, hay harvesting, earth moving, irrigation, minimum tillage, metal-building construction, liquid-nitrogen and anhydrous-ammonia-gas fertilizer applications, sectional-house construction and grain harvesting.

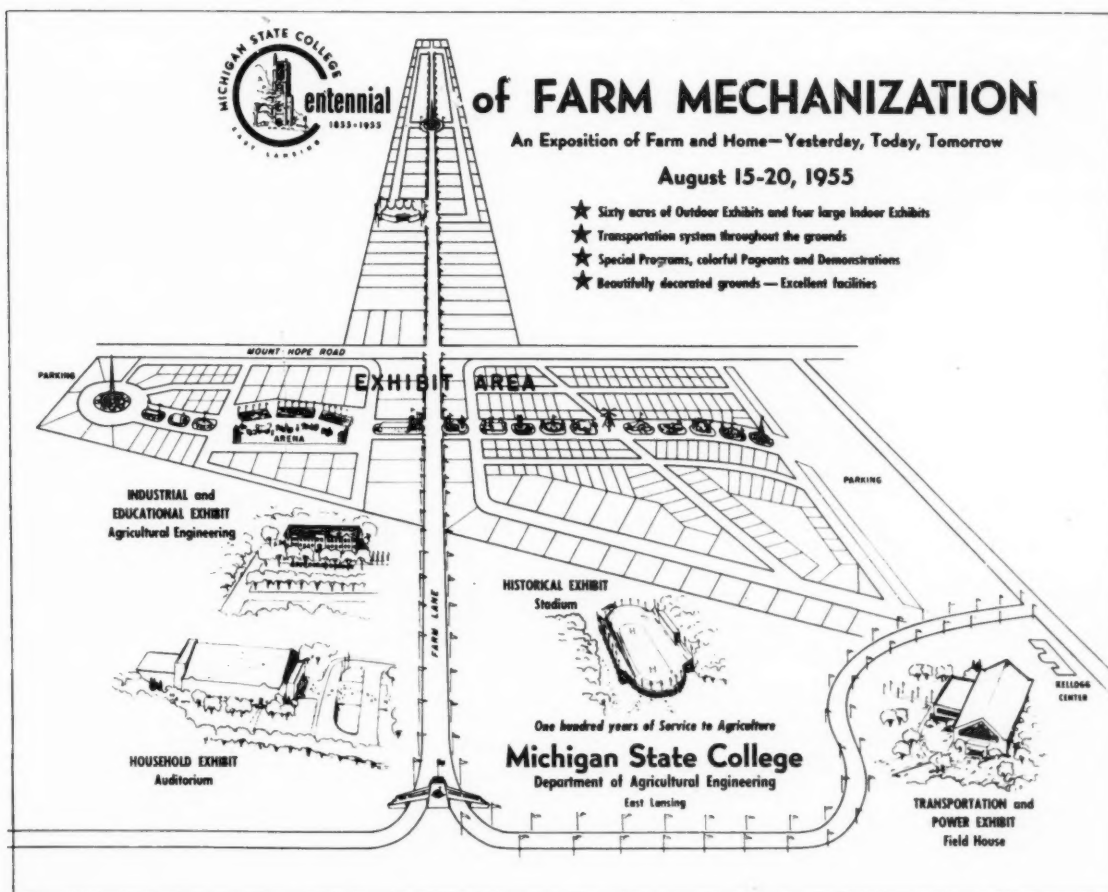
Pageants

A feature of each day's performance will be the hour and a half pageant of Farm Mechanization. This will be the story of farming of yesteryear, its development into the farm mechanization of today, and a glimpse into what mechanization may mean to the farm of tomorrow. Beautifully decorated floats and hundreds of people will combine to illustrate this historic drama.

Among the themes to be developed will be tillage of the soil from the crooked-stick plow to modern once-over tillage. The old sod house will be transformed into the modern farm home with its many modern conveniences and the old oil lamp replaced by electricity. It will show how our soils are becoming increasingly productive through irrigation and drainage. Problems of safety and maintenance which these modern and futuristic developments present will also be demonstrated.

To date, about one-half the available exhibit space has

(Continued on page 880)



General view of the layout of facilities for the Centennial of Farm Mechanization at Michigan State College, August 15 to 20, 1955

Consumptive-Use Requirements for Water

(Continued from page 873)

depletion ranged from less than one percent for many tributary basins to 53 percent for the portion of the Snake River Basin between Heise and King Hill, Idaho.

The Blaney-Criddle and Lowry-Johnson methods were used to estimate consumptive use for some 4,000,000 acres of irrigated land in the Columbia River Basin. The report states: "The values derived by these two indirect methods agree very closely with the measured values. It is therefore believed that either method properly used will yield reliable estimates of net consumptive use for areas where direct measurements are not available."

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The Sanitary Engineer

FORMULAS relating to behavior and self-purification phenomena of streams become more involved with the increasing load and variety of organic and inorganic pollutants. Paralleling this is the ever-increasing need for water to sustain our expanding technology. This increasing need against fixed supply heightens the necessity for conservation. Water resources are more than ever a political issue. On the subject of water resources, certainly the sanitary engineer is at home. If he can balance his professional ability with public leadership, he will have the privilege and opportunity to see that these issues may be sensibly resolved in the public interest.

Sanitary engineering has progressed along many other fronts. Milk and food sanitation is a major activity consuming half the time and effort of sanitation personnel in community health agencies. The multibillion dollar food industry with its continually changing methods of production, processing, and handling, presents the sanitary engineer many opportunities for public service. . . .

Closely allied to vector control is the field of refuse disposal. Except for improvements in the techniques of landfill, the sanitary engineer has neglected this subject. Admittedly, there has been a lack of public support. Recently public attitudes have changed. Areas suitable for landfill are becoming scarce, and there is increasing need for reclaiming or salvaging the organic content and other valuable fractions contained in garbage and refuse. Composting to produce a humus-fertilizer is for the first time attracting real interest in the United States. This same conservation awareness is evident in sewage-treatment research. Studies are being directed toward reclaiming not only the water contained in sewage but also the fixed nitrogen. The time is approaching in the nation's history when we should begin to throw away less and less. — Mark D. Hollis in *Midwest Engineer* for September, 1954.

Centennial of Farm Mechanization

(Continued from page 879)

been contracted. This exposition is attracting the interest of foreign groups as well as the people of this country. It will promote a wider recognition of agricultural engineering as a profession and will emphasize the importance of the farm equipment industry as a whole. A commercially prepared documentary film will be made during the exposition.

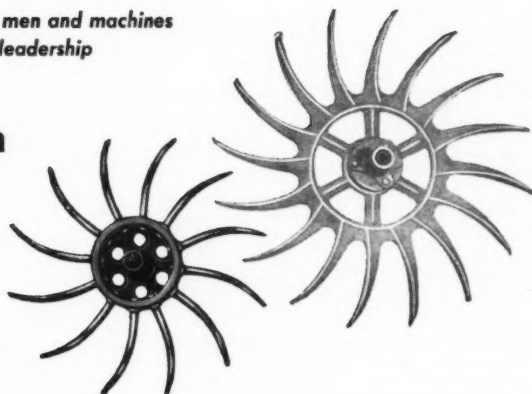
Publicity will be given the exposition in national advertising, radio and television. An advisory promotion committee from industry headed by George A. Webber, advertising supervisor of Consumers Power Company, is giving valuable advice and doing much of the actual work of publicizing the event.

Chief responsibility for the planning and execution of the Centennial of Farm Mechanization lies with a ten-man executive committee in the Agricultural Engineering Department of Michigan State College. It is headed by A. W. Farrall, department head and general chairman, and R. L. Maddex, executive chairman. Further information about the exposition may be had by writing the Agricultural Engineering Department, Michigan State College, East Lansing.

A report to you about the **TEAMWORK** of men and machines
that helps maintain International Harvester leadership

New spoke-wheel design puts longer life into McCormick® rotary hoes

Weedy, crusted fields will get cleaner cultivation, and weeder wheels will last longer, do better work because of the tough, high-carbon, shock-resistant steel being used in the new spoke-wheel design for McCormick rotary hoes. This new wheel is another example of how IH metallurgists, research men, designers, engineers and manufacturing men work together to improve product quality and performance, while keeping costs at a minimum.

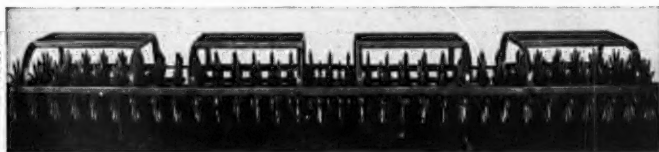


New design, smaller diameter weeder wheel (left), with 12 steel spokes riveted to the hub, will soon replace the larger, 16-prong malleable iron weeder wheel (above) on McCormick rotary hoes. New-type forged spokes are extremely stiff, resist bending and breakage. Wheels last longer, cultivate cleaner.



Weeder wheel spokes are riveted securely into drilled holes in the hub in this operation. In earlier operations, tough, high-carbon steel bars are sheared into 14-inch lengths;

heated, elongated hydraulically to form two 8-inch spokes; then shaped to a slight curve. New design for weeder wheels of McCormick rotary hoes adds durability at lowest cost.



Crops get off to a good clean, fast start—and get the jump on weeds—when cultivated with the new 4-section McCormick rotary hoe with new-type, deep-penetrating spoke weeder wheels. Wheels can be easily removed from axle and replaced individually at low cost.

For more details, write for free engineering paper, "New Spoke-Wheel Design for McCormick Rotary Hoes." There is no obligation. Send a post card with your name and address to International Harvester Company, P. O. Box 7333, Chicago 80, Illinois.



INTERNATIONAL HARVESTER

International Harvester products pay for themselves in use—McCormick Farm Equipment and Farmall Tractors
... Crawler Tractors and Power Units ... Refrigerators and Freezers—General Office, Chicago 1, Illinois.

NEWS SECTION

President Nutt Addresses Georgia Section

AN ADDRESS by ASAE President George B. Nutt, head, agricultural engineering department, Clemson Agricultural College, opened the program of the meeting of the Georgia Section of ASAE held at the Dinkler-Plaza Hotel, Atlanta, Ga., November 4 and 5. Mr. Nutt's address was followed by greetings from Society's central office by Secretary Frank B. Lanham.

Two other speakers at the session included J. W. Harwell, U.S. Soil Conservation Service, who discussed current aspects of conservation farming as related to agricultural engineering, and R. S. Stevenson, an executive of Allis-Chalmers Mfg. Co., who talked on farm mechanization as a factor in the progress of southern agriculture. Bud S. Moss, Georgia Power Co., chairman of the Georgia Section, presided at the session. During the afternoon of November 4 the group attending the meeting were given a tour of the Atlantic Steel Co.'s plant at Atlanta. At the Section dinner in the evening, R. H. Driftmier, University of Georgia, presided as toastmaster. The speaker for the occasion was Henry Cohen of the Moultrie National Bank.

At the closing session of the meeting on November 5, J. L. Shepherd, agricultural engineer of the Coastal Plain Experiment Station and vice-chairman of the Georgia Section, presided as chairman. The program opened with a talk on medium and heavy machinery for farmers by C. C. Mullen of the Rome Plow Co. He was followed by C. W. Chapman, U.S. Soil Conservation Service, who discussed the watershed approach to soil and water conservation. Graham Daniel, of the Russell Daniel Irrigation Co., spoke on designing irrigation systems. The banker's role in irrigation was discussed by James W. Blanchard of the Installment Credit Committee of the Georgia Bankers' Assn. The concluding talk was on the Farmers' Home Administration role in irrigation by R. L. Vansant of the FHA office at Atlanta.

Pacific Northwest Section Elects Morgan

ROBERT M. MORGAN, sales manager, irrigation division, R. M. Wade & Co., Portland, was elected chairman of the Pacific Northwest Section of the American Society of Agricultural Engineers at the Section's yearly meeting held at the Davenport Hotel in Spokane, Wash., October 14 and 15. He succeeds J. W. Martin, head, agricultural engineering department, University of Idaho.

At this meeting the Section elected new first, second, third and fourth vice-chairmen as follows: Stephen J. Maech, irrigation engineer, Soil and Water Research Branch, ARS, USDA, Prosser, Wash.; Glen Cushing, laboratory supervisor, Puget Sound Power and Light Co., Puyallup, Wash.; J. C. Wilcox, senior officer in charge of soil and irrigation investigations, Dominion Experiment Station, Summerland, B. C.; Larry Bagnall, student in agricultural engineering, The State College of Washington, Pullman.

The new Section secretary is Dale E. Kirk, agricultural engineer, Oregon State College, Corvallis.

ASAE Meetings Calendar

December 16—CONNECTICUT VALLEY SECTION, 26 Central St., West Springfield, Mass.

January 21—IOWA-ILLINOIS SECTION, American Legion Club, 1623 15th St., Moline, Illinois

January 28—MICHIGAN SECTION

January 28-29—PACIFIC COAST SECTION, Fresno State College, Fresno, Calif.

February 7-9—SOUTHEAST SECTION, Brown Hotel, Louisville, Ky.

April 1 and 2—MID-CENTRAL SECTION, Hotel Robideaux, St. Joseph, Mo.

April 14 and 15—PENNSYLVANIA SECTION, Penn. State University, State College

June 12-15, 1955—48TH ANNUAL MEETING, University of Illinois, Urbana

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

Iowa-Illinois Section Hears Ronning

MARTIN RONNING, chief engineer, power machinery division, Minneapolis-Moline Co., was the featured speaker on the program of the November 5th meeting of the Iowa-Illinois Section of ASAE held in East Moline, Ill. His discussion of the development and application of the uni-tractor developed by the company under Mr. Ronning's direction was received with a great deal of interest by those in attendance.

Following the dinner held in the American Legion Club, the program of the meeting was opened by short talks by four students—two from the University of Illinois, one from the University of Wisconsin and one from Iowa State College—who interestingly described their experiences in industry.

The Section chalked up the next-to-the-largest record of attendance for a meeting since the Section was organized a few years ago. A total of 193 attended the meeting. The largest previous record was for the spring meeting held this year in April with an attendance of a little over 200.

The next meeting of the Section is scheduled for January 21.

Wood Talks on Irrigation Wells

IVAN D. WOOD, a past-president of ASAE, and irrigation engineer, Soil Conservation Service, USDA, addressed the meeting of the Oklahoma Section of ASAE at Stillwater on November 12 on developing irrigation wells. E. R. Daniel, agricultural engineer, Oklahoma A. & M. College, reviewed the research being done on treating "gyp" water electrically. The farm storage and conditioning of grain was discussed by E. D. Anderson, director of agricultural extension, Stran-Steel Div., Great Lakes Steel Corp.

E. W. Schroeder, head of the OAMC agricultural engineering department, reported on the over-all agricultural engineering activity at that institution. Machinery for pasture improvement was the subject of a talk by R. M. Merrill, product research engineer, Deere & Company. State Conservationist Ray Walker reviewed the work that is going on in soil and water conservation in Oklahoma.

John Johns, vice-chairman of the Oklahoma Section and supervisor of rural sales and service of the Oklahoma Gas and Electric Co., presided at the forenoon session, and the presiding chairman of the afternoon session was Fred R. Gray, secretary of the Section, and construction engineer, Soil Conservation Service, USDA.

Mechanization in Sweden

AT THE November 12 meeting of the Washington (D.C.) Section of the American Society of Agricultural Engineers, Helmer Olsson, agricultural counselor of the Swedish Embassy, addressed Section members and friends on the subject of agricultural mechanization in Sweden.

H. F. Miller, farm machinery section, Agricultural Engineering Research Branch, ARS, USDA, acted as chairman of the meeting.

Memorial to George Kable

IN RECOGNITION of the outstanding contribution of the late George W. Kable, a past-president of ASAE, and for many years editor of *Electricity on the Farm* magazine, to the promotion of farm electrification in the State of West Virginia and throughout the country, the West Virginia Section of the American Society of Agricultural Engineers presented the plaque to the West Virginia Farm Electrification Council shown in the accompanying illustration. This plaque has been hung in the farm electrification building at Jackson's Mill, W. Va.

Cherries and Gas Turbines on Michigan Section Program

HYDROCOOLING and transportation of red tart cherries in water was the subject of an illustrated talk by Jordan H. Levin, associate agricultural engineer, U.S. Department of Agriculture, opening the technical program of a meeting of the ASAE Michigan Section in the agricultural engineering building at Michigan State College, East Lansing, on October 23. He was followed by James L. Child, Jr., sales engineer, The Hancock Brick and Tile Co., who discussed the many engineering aspects involved in the manufacture of clay drain tile.

(News continued on page 884)



Geo. W. Kable memorial plaque



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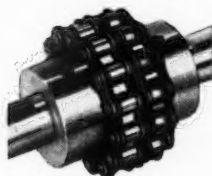
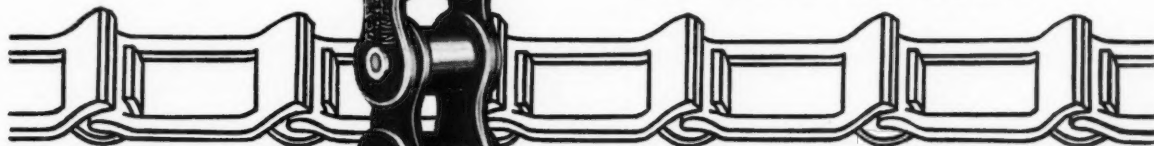
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NEWS SECTION

(Continued from page 882)

The third speaker on the program was Dr. Andrew Kucher, director of the scientific laboratory of Ford Motor Co., who presented an interesting discussion, including a sound motion picture in color, on gas turbines and the possibility of their adaptation in farm tractors. He was followed by Dr. L. L. Otto, mechanical engineering department, Michigan State College, who discussed briefly the development of diesel and spark-ignition internal-combustion engines.

A total of 125 ASAE members and friends were registered at the meeting, and in addition 60 ladies accompanying their husbands were entertained during the technical program. About 170 people attended the luncheon following the program, at which A. W. Farrall, head of the agricultural engineering department, Michigan State College, discussed the extensive plans that are being made for the Centennial of Farm Mechanization to be held on the MSC campus next August 15-20.

Future meetings of the Section are scheduled for Friday, January 28, and on Friday, April 22. At the first of these meetings the subject featured will be tractor transmissions of the present and future.

Pacific Coast Section Meets in January

THE 1955 annual meeting of the Pacific Coast Section of ASAE will be held January 28 and 29 on the new campus of Fresno State College at Fresno, Calif. Write W. W. Weir, Section secretary, 330 Hilgard Hall, University of California, Berkeley, for information concerning the program and accommodations for those attending the meeting. A preview of the program will be published in AGRICULTURAL ENGINEERING for January.

Ohio Section Mixes Engineering and Football

MEMBERS and guests of the Ohio Section of ASAE rallied in Columbus, November 19 and 20, to back Ohio's progress in agricultural engineering and its successful bid for the Big Ten football championship.

Robert J. McCall, chairman of the Section, opened the meeting at 1:30 p.m., Friday, November 19, and introduced Truman Goins, program chairman, who presided. In the varied program, C. Edwin Smith, area engineer, Soil Conservation Service, reported on the Upper Hocking watershed project at Lancaster; Curt Romaine, sales engineer, J. I. Case Co., talked on the corn harvester method of harvesting the complete corn plant for feed; and J. B. Stere, agricultural engineer, C. A. McDade Co., discussed opportunities and trends of integral-horsepower, single-phase farm electric motors.

At a short business meeting future meeting plans were discussed. It was decided that the Section would hold its next meeting in February or March and would cooperate informally in the Engineers' Day activities of the University in May.

More than 80 members and guests attended the Section dinner on Friday evening in the new Ohio Union Building. G. W. McCuen, toastmaster, opened the program by introducing the wives of the members of his department.

Gordon Carson, dean of engineering, Ohio State University, was the featured speaker.

(Continued on page 888)

NEWS OF ASAE MEMBERS

Theo Brown, a Fellow of ASAE, recently retired after more than a half century of active and invaluable service to the farm equipment industry. For nearly 30 years, 1923-1952, he was a member of the board of directors of Deere & Company. He is a former head of experimental work at the general office of the company, and he had served as a research engineering consultant until two years ago when he asked to be relieved of administrative responsibilities.



THEO BROWN

A graduate of Worcester Polytechnic Institute in Massachusetts, on leaving school Mr. Brown spent the year 1901 with the Washburn Wire Co. and the following year with the New England Butt Co. From then until 1911 he was employed by the Richardson Mfg. Co. of Worcester, which at that time manufactured manure spreaders under license from Kemp and Burpee, Syracuse, N. Y. He early showed his inventive ability by major improvements on the Kemp spreader, with the result that when Deere & Co. bought the Kemp & Burpee business, Mr. Brown joined the Deere organization. His first work with Deere & Co. was at the Marseilles Co. plant in East Moline, now the John Deere Spreader Works. He was superintendent there from 1912 until 1916, when he was made head of the experimental department of the John Deere Plow Works. Subsequently he supervised the experimental and design work at the general office of the company.

In recognition of his outstanding engineering achievements in the farm machinery field, the American Society of Agricultural Engineers awarded him the Cyrus Hall McCormick Gold Medal in 1935. At that time he had to his credit more than 100 patents which later increased to over 150.

In later years much of Mr. Brown's research work has been on the promotion of safety, in connection with which he did outstanding work for the farm division of the National Safety Council, and in recognition of this the Council presented to him in October its highest citation for meritorious service in the field of safety.

Over the years of his affiliation with ASAE, Mr. Brown has served as a member of the Council, as an active participant on various committees, and as an invaluable counselor on many Society matters.

Mr. Brown is a native New Englander and he and Mrs. Brown own a summer home near Princeton, Mass., where they plan to spend their summers. They will also continue to maintain their home in Moline.

James E. Ferguson, who has been a sales engineer for Southern Irrigation Co. for the past 2 years, was recently appointed general manager of the company, succeeding W. J. Liddell who has resigned. He is an agricultural engineering graduate of the A. & M. College of Texas and received a master's degree in irrigation at the Utah State Agricultural College. Following graduation, he initiated the irrigation research program in the state of Arkansas, and later was a commercial engineer with the Central Power and Light Co., Uvalde, Tex.

Stanley W. McBirney recently returned to the U.S. Department of Agriculture from an assignment in Cuba with the Foreign Operations Administration (Point IV) where he was working on a kenaf fiber project. He has been placed in charge of a new research project at Wenatchee, Wash., on equipment and methods for the production, harvesting, and farm handling of tree fruits, a project of the Agricultural Engineering Research Branch (ARS), USDA. First emphasis will be on the harvesting and orchard-handling phases.

W. J. Liddell has resigned as general manager of Southern Irrigation Co. to start a wholesale distribution business in partnership with his brother-in-law. The organization will be known as the Delta Irrigation Co. and will be located at Memphis, Tenn.

Mr. Liddell has been with the American Portable Irrigation Co. group for six years. For a year and a half he was sales engineer in the Southeast, and was then made sales manager of Sunset Engineering Co., Riverdale, N. J. Two years later he organized the Southern Irrigation Co. as a separate wholesale branch of the parent company located at Memphis.

Talmadge E. Duncan recently joined the agricultural engineering staff of the University of Arkansas, Fayetteville.

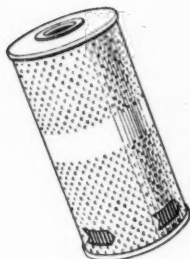
Paul L. Lyman, until recently employed as engineer on the Molokai Plantation of the California Packing Corp., in Hawaii, has accepted the position of chief plantation engineer of the Philippine Packing Corp. located at Del Monte, Mindanao, Philippine Islands. The company is engaged in the production of pineapples and Mr. Lyman will be responsible not only for the housing construction and maintenance for employees of the plantation but also for the construction and maintenance of all special equipment that is used only in the pineapple industry, as well as the standard equipment such as trucks, tractors, automobiles, tillage equipment, etc.

NECROLOGY

Fred B. Hamilton, irrigation engineer, Soil Conservation Service, USDA, stationed at the University of Nebraska, passed away September 23, at Lincoln. His health had been failing for the past year.

Born at Hillrose, Colo., in 1911, he graduated from Colorado A & M College in 1935, in civil and irrigation engineering. After a few months of junior engineering experience with the U.S. Bureau of Public Roads at Denver, he transferred to the Soil Conservation Service and served in increasingly responsible capacities in Colorado and other western states. For two years, 1946-48, he was in charge of engineering and conservation work on ranches in three states for the Diamond A Cattle Co. Then he returned to the SCS as irrigation engineer and handled its research program at Lincoln up to the time of his passing.

A member of ASAE since 1949, he was also a member of the Soil Conservation Society of America and had served a term as president of its Lincoln Chapter. He was a member of the Second Baptist Church. Surviving are his widow, Dorothy Dee, four daughters, one son, his father, and a sister and brother.



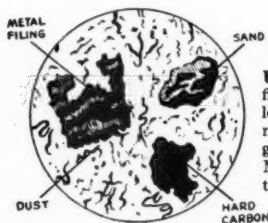
1.

High full-flow rates within practical design dimensions: Purolator's famous "accordion-pleated" Micronic* filter element has up to ten times more filtering area than old-style filters—gives high flow rates in a minimum of space.

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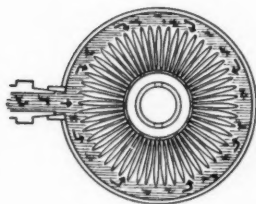


3.

Maximum dirt storage capacity: The pleated design of the Purolator Micronic filter element provides many times more dirt storage space than old-style filters. This important advantage means uniform, efficient performance throughout a long service life.

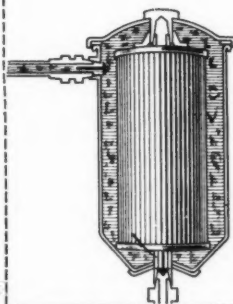
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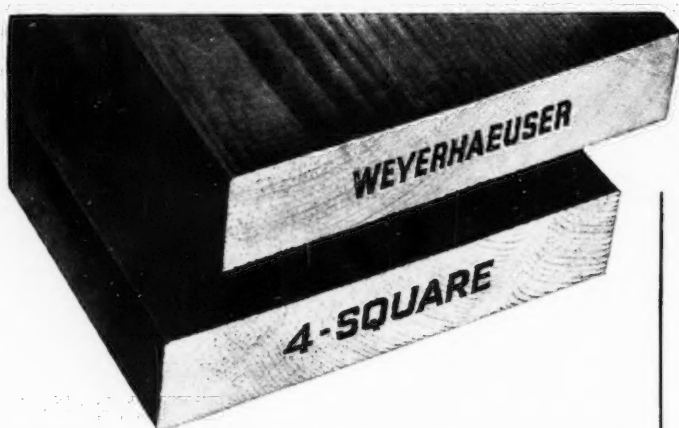
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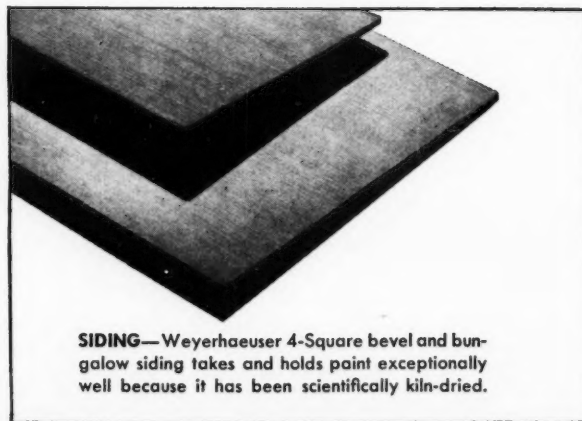
The use of well-known, trade-marked materials is sound building practice—and always wins appreciative approval from home and building owners.

Builders and owners see in the Weyerhaeuser 4-Square brand name a familiar mark of quality. This confidence is the result of many years of advertising and, more important, the fine record of performance of every product bearing the Weyerhaeuser 4-Square trade mark.

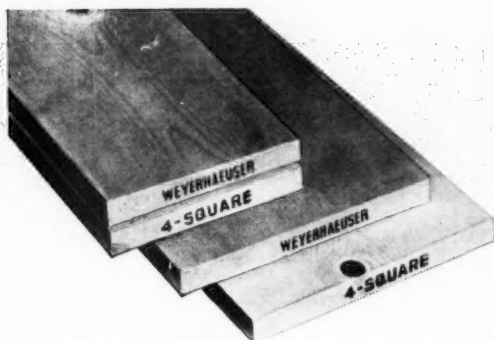
One of the reasons for the widespread acceptance of Weyerhaeuser 4-Square is the fact that every piece of lumber bearing this brand has been scientifically kiln-dried. Controlled seasoning means that this lumber holds its size and shape remarkably well... has maximum strength and stiffness... takes paint and other finishes. These characteristics, plus the benefits of precision sawing and surfacing,

proper grading, careful handling and shipping, mean that Weyerhaeuser 4-Square Lumber is consistently high in quality.

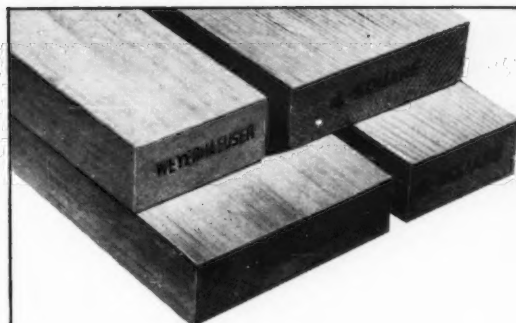
This lumber, in a wide range of species, grades and sizes, is available through local Weyerhaeuser 4-Square Lumber Dealers.



SIDING—Weyerhaeuser 4-Square bevel and bungalow siding takes and holds paint exceptionally well because it has been scientifically kiln-dried.

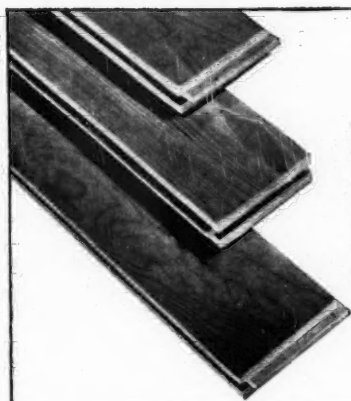


BOARDS—Every board bearing this brand name has been seasoned prior to manufacture.

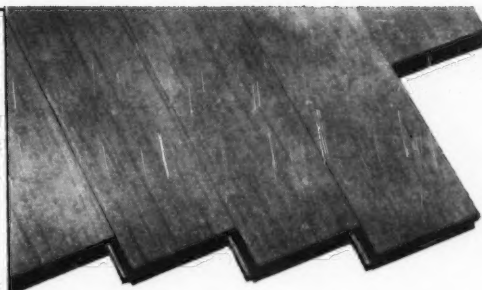


DIMENSION—Scientifically kiln-dried lumber contributes to sound, durable construction.

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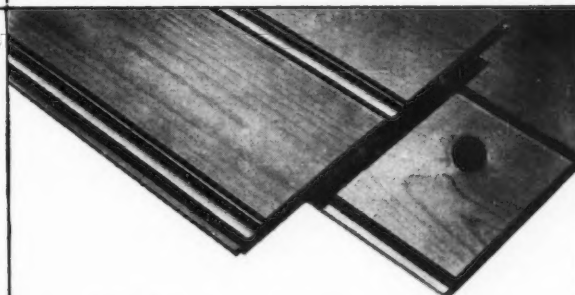
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This popular item
eliminates waste and
reduces building time
—proper seasoning
gives it maximum
strength.



FLOORING—Controlled kiln-drying means a firm, smooth surface for superior appearance and wearability.

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NEWS SECTION

(Continued from page 884)

While showing a strong talent for good humor, his talk on "Scientific Sense" emphasized challenges facing engineers today.

The OSU agricultural engineering department held open house for a short period before the Saturday morning session.

In reporting on feed storage and handling, J. D. Blickle, Ohio agricultural engineering extension specialist, indicated substantial progress in saving feed values and reducing labor requirements on medium to large Ohio farms.

A report on wind tunnel studies of agricultural aircraft distributors, by James E. Henry, Ohio Agricultural Experiment Station, showed some of the means being tried to improve the uniformity of distribution of dusts, fertilizers, and seeds from airplanes, and techniques used to determine the distribution.

The subject of interplantings in wide-row corn discussed by J. L. Haynes, professor of agronomy, Ohio Agricultural Experiment Station, emphasized erosion control as a primary objective, and the problem of arriving at an optimum compromise between value of the corn yield, value of the cover crop stand, and adaptation of the production program to the practical economics of mechanized operations.

Ag Engineers on USDA Committee

FOUR ASAE members, all graduate agricultural engineers, are included on the 11-member committee recently appointed by Secretary of Agriculture Ezra Taft Benson to advise the U.S. Department of Agriculture on its research activities "to provide better homes, buildings, machinery, and equipment for farm families." The Committee will serve for one meeting, on March 7 to 9, 1955. The four ASAE members include W. D. Hemker, Westinghouse Electric Corp.; W. G. Kaiser, formerly Portland Cement Assn.; S. M. Madill, Deere & Co., and F. E. Price, dean of agriculture, Oregon State College.

Farm Chemurgic Conference

THE National Farm Chemurgic Council, with headquarters at 1519 Connecticut Ave., N.W., Suite 4, Washington 6, D.C., will hold its next annual chemurgic conference at the Deshler-Hilton Hotel, Columbus, Ohio, March 22-24, 1955. The program will feature latest developments in agricultural research with particular reference to chemurgy. Information concerning details of the program, etc., may be obtained direct from the conference chairman, John W. Ticknor, National Farm Chemurgic Council, 350 Fifth Ave., New York, N. Y.

Dairy Engineering Conference

THE third annual national dairy engineering conference sponsored by the agricultural engineering department of Michigan State College, in cooperation with the dairy department and the continuing education department of MSC and several industrial concerns, will be held at the Kellogg Center on the Michigan State College campus, East Lansing, March 8 and 9, 1955. Featured on the program of the conference will be authorities from all over the United States who will discuss timely engineering problems of the dairy industry.

Copies of the final program will be available about January 15. For details of the conference write to Carl W. Hall, agricultural engineering dept., Michigan State College, E. Lansing.

HAWTHORN-MELODY FARMS DAIRY collects 45,000 pounds of fluid milk daily with Stainless Steel farm tanks

• Hawthorn-Mellody Farms Dairy, Whitewater, Wis., is another progressive dairy that has adopted the bulk milk handling system with outstanding results.

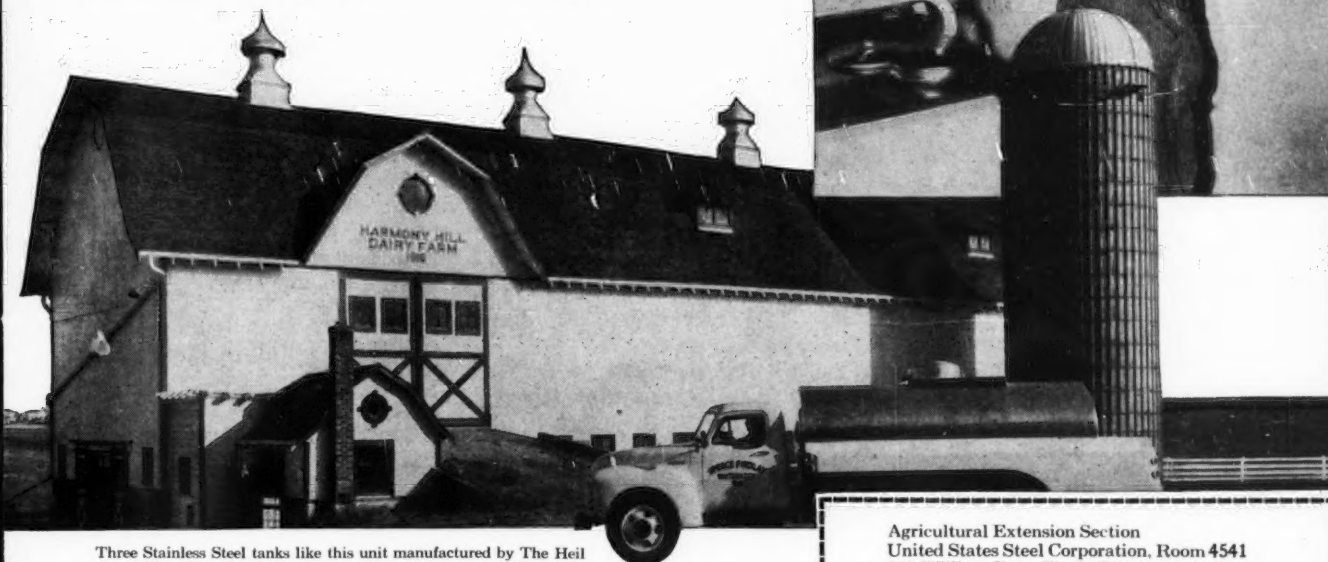
Using three Stainless Steel tank trucks, this processor receives 45,000 pounds of fluid milk from Stainless Steel bulk holding tanks on farms every day. Each truck calls at 15 farms and averages 80 miles in 3½ hours. Old-fashioned methods of milk handling brought in only 7,500 pounds from calls on 10 or 12 farms covering a distance of 50 miles and taking 4½ hours.

Use of the bulk milk handling system also eliminates heavy lifting, together with much time-consuming cleaning and sterilizing. Bacteria count control is better, too, and weights and samples are taken before the truck leaves the producer's farm.

If you'd like more information on the bulk milk handling system, mail the coupon below. As a producer of Stainless Steel, we have worked closely with manufacturers of Stainless Steel tanks and have accumulated valuable information on this modern method of milk handling. We're glad to make it available to you.



Driver Spence Findlay checks the Stainless Steel measuring rod (above) and takes a sample from the Stainless Steel farm holding tank at one of the stops along his route.



Three Stainless Steel tanks like this unit manufactured by The Heil Co., Milwaukee, Wisconsin, pick up 45,000 pounds of fluid milk daily for Hawthorn-Mellody Farms Dairy at Whitewater, Wisconsin.

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Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Ackermann, William C.—Head, watershed hydrology section (ARS), Plant Industry Station, Beltsville, Md.

Ahne, Jerome J.—Graduate student in agricultural engineering, Pennsylvania State University, Box 819, Nittany PO, State College, Pa.

Akramuzzaman, Mohammed—Graduate student in irrigation and drainage, Utah State Agricultural College, Logan Utah. (Mail) 112 East Center

Anderson, Merrill J.—Engineer, Ethyl Corp., 1600 W. 8 Mile Road, Ferndale 20, Detroit, Mich.

Beck, Donald R.—Materials engineer, Missouri State Highway Dept., Jefferson City, Mo. (Mail) 326 E. Dunklin St.

Benedict, W. L.—Manager, rural development, Northern States Power Co., 15 So. 5th St., Minneapolis, Minn.

Blickle, Joseph D.—Professor of agricultural engineering, Ohio State University, Columbus, Ohio.

Blough, R. S.—Owner and manager, Fairfield Engineering Co., Fairfield, Iowa. (Mail) Box 528

Brown, Hugh A.—Sales manager, industrial pump and irrigation div., Mitchell Lewis & Staver, 801 S.E. Alder St., Portland, Ore.

Busch, Charles D.—Graduate student in agricultural engineering, Utah State Agricultural College, Logan, Utah. (Mail) Quonset 175

Cruickshank, Hugh D.—Irrigation and hydraulic engineer, H. D. Cruickshank & Co., 7 Auvergne Ave., Newtown, Hobart, Tasmania

Cutler, Willard A.—Extension agricultural engineer, Michigan State College, East Lansing, Mich. (Mail) 222 Agricultural Engineering Bldg.

Day, Donald L.—USAF. (Mail) RR 1, Leedey, Okla.

Doubt, Paul D.—Civil engineer, engineering div., design section, (SCS), USDA, Beltsville, Md.

Dow, George V.—Head, development dept., John Deere Waterloo Tractor Works, Waterloo, Iowa

Flournoy, Felton B.—Farm advisor, Jackson Electric Membership Corp. (Mail) 11a, Ga.

Foster, Frank S.—Assistant sales manager, Caterpillar Tractor Co., San Leandro, Calif. (Mail) 800 Davis St.

Fox, Sherman D.—Competitive analyst, Tractor & Implement Div., Ford Motor Co., Birmingham, Mich.

Frazier, Elvin H. Jr.—Sales engineering, Aeroglide Corp., 510 Glenwood Ave., Raleigh, N. C.

Garber, Dwight L.—Rural application engineer, Dayton Power and Light Co., 25 N. Main St., Dayton, Ohio

Gentner, Delbert E. Jr.—Zone manager, Farm Supply, Inc. (Mail) 2113 Quentin Ave., Lansing 17, Mich.

Goss, Onno M.—Manager of farm equipment sales, Columbian Steel Tank Co., 1509 West 12th St., Kansas City, Mo.

(Continued on page 892)

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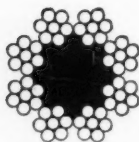
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Applicants for Membership

(Continued from page 890)

Griffin, Robert G.—Finishing room, International Paper Co., Bastrop, La. (Mail) 123 West Jefferson Ave.

Hill, Fred L.—Chief engineer, Blackwelder Mfg. Co., Rio Vista, Calif. (Mail) PO Box 808

Hoyt, Charles T.—Layout draftsman, McCormick Works, International Harvester Co. (Mail) 749 118th St., Whiting, Ind.

Ireland, Gerald B.—College trainee, Caterpillar Tractor Co. (Mail) 8A Park Drive, N. Pekin, Ill.

Kahl, William H. — Graduate assistant, Michigan State College. (Mail) 512 S. Hayford, Lansing, Mich.

Kelly, Floyd Jr. — Work unit engineer (SCS), USDA, Box 535, Holly, Colo.

Kenjowski, Nicholas—Product planning dept., Tractor & Implement Div., Ford Motor Co., Birmingham, Mich. (Mail) 1024 Southlawn Dr.

Lawson, Lawrence L.—Laborer, McCormick Deering Implements. (Mail) 5827 Johnston Rd., RR 14, New Westminster, B.C., Canada

Lindstrom, Harold R.—Senior product engineer, John Deere Wagon Works, Moline, Ill.

McEachren, John C.—Agriculturist, MacMillan & Bloedel Sales (Ont.) Ltd., PO Box 40, Toronto 18, Ont., Canada

Manbeck, Deane M.—Student, University of Minnesota. (Mail) RR 2, Box 33, Little Falls, Minn.

Markley, Richard—Chief engineer, Dairy Equipment Co., 1444 E. Washington St., Madison, Wis.

Meyer, Lawrence D.—Assistant in agricultural engineering, University of Missouri. (Mail) RR 3, Concordia, Mo.

Minick, Leonard S.—Salesman, The B. F. Goodrich Co., 4646 W. Lake St., Chicago, Ill.

Munson, Randall G. — Development engineer, Wallace & Tiernan, Inc. (Mail) 21 Roosevelt St., Roseland, N. J.

Overman, Charles L. — Electrification adviser, Blue Ridge Electric Membership Corp., Lenoir, N. C.

Perry, Gordon C.—Extension specialist in agricultural engineering, Cornell University. (Mail) RD 2, Naples, N. Y.

Reep, Jacob E.—Engineer in seed processing dept., N. C. Foundation Seed Producers, Inc. (Mail) RR 1, Lincolnton, N. C.

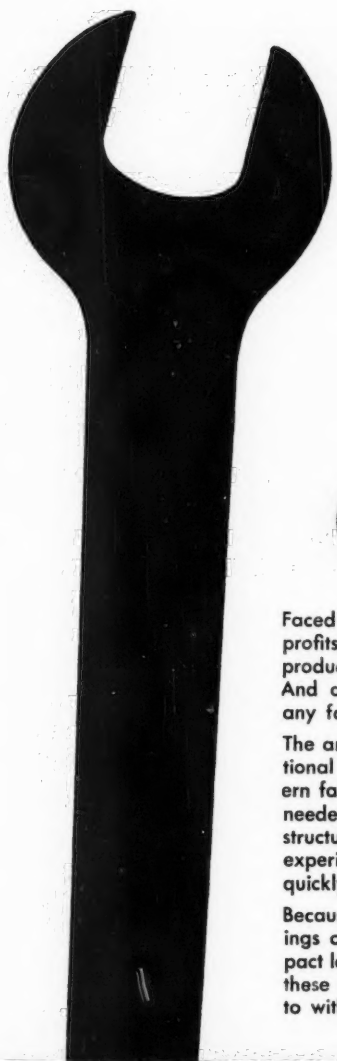
Risser, Roger L.—Agricultural engineer (SCS), USDA. (Mail) RR 4, Lebanon, Pa.

Roberts, Emmett S. — Executive director, Belle Glade Housing Authority, PO Box 488, Belle Glade, Fla.

Roberts, Roy L. Jr.—Agricultural engineer (SCS), USDA. (Mail) 2C Parkway, Greenbelt, Md.

Roy, Shunil E.—Graduate assistant in agronomy, Pennsylvania State University State College, Pa. (Mail) 528 S. Pugh St.

(Continued on page 894)



HOW TO TIGHTEN UP ON FARM PRODUCTION COSTS



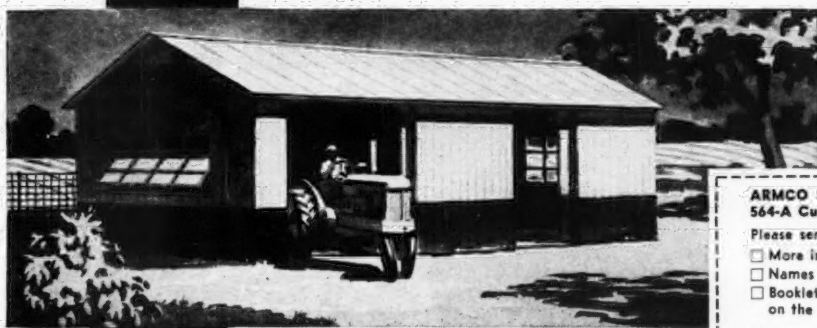
Faced with the challenge of boosting farm profits, ag engineers are looking for new production tools to reduce operating costs. And among the most important tools on any farm are its buildings.

The answer to this need for low-cost, functional farm shelter is *steel buildings*. Modern farmers can't afford to spend the time needed to erect old-fashioned conventional structures. Steel buildings go up fast. Inexperienced farm hands can do the job quickly and easily with ordinary wrenches. Because they're fire-resistant, steel buildings can be put close together in a compact layout. And as a farm's needs change, these buildings can be moved or added to without loss of materials.

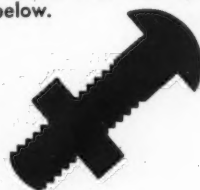
Steel buildings painted white outside reflect the summer sun, help keep interiors cool. No other uninsulated building material gives better results. This means more comfortable quarters for livestock and better working conditions for the farmer.

To keep building maintenance at minimum, many manufacturers of steel farm buildings use Armco ZINCGRIP—a specially zinc-coated steel that gives long protection against rust. In 18 years of service, ZINCGRIP has proved itself as the dependable, low-upkeep steel for farm use.

If you are designing steel buildings or equipment, you can obtain further information on this special sheet steel by sending the coupon below.



A steel building like this machinery shed can be put up by an inexperienced crew in a few days after the foundation has been laid. This includes installation of all doors and windows—which can be added wherever and whenever needed.



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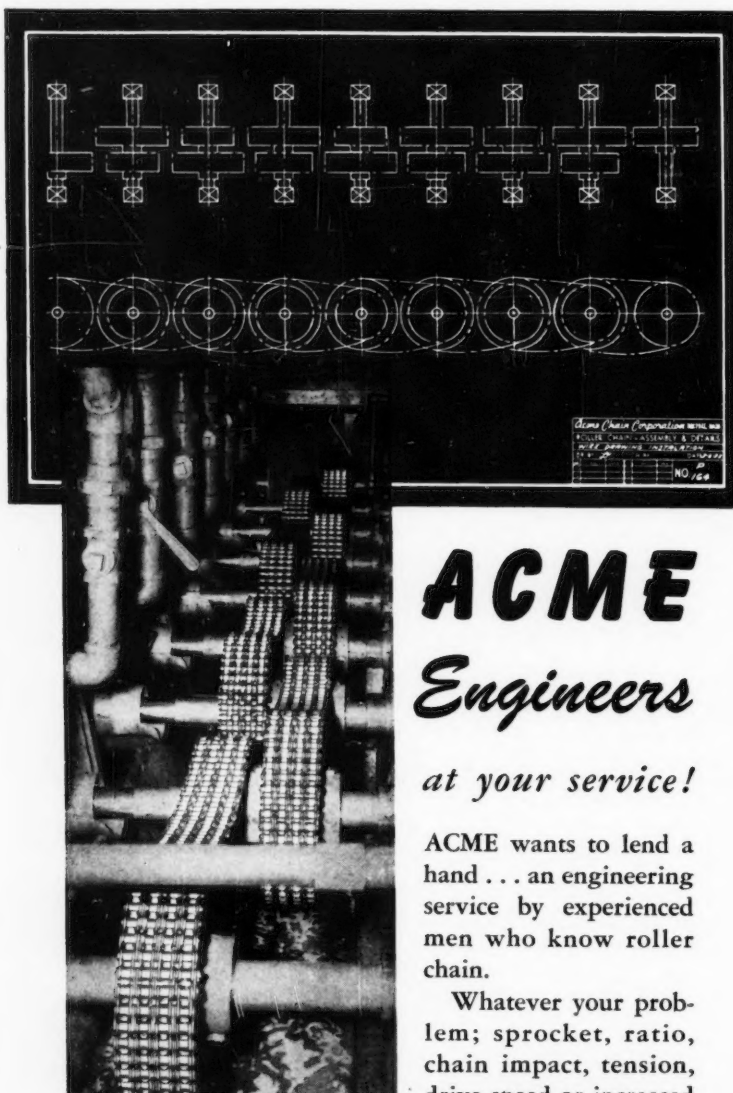
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Applicants for Membership

(Continued from page 892)

- Scheerer, John W. II — Junior engineer, Philadelphia Electric Co. (Mail) 30 Hanum Dr., Ardmore, Pa.
- Schertz, Cletus E.—2nd Lt., USAF. (Mail) Benson, Ill.
- Smajd, Carl F.—Tire design engineer, U.S. Rubber Co., 6600 E. Jefferson Ave., Detroit 32, Mich.
- Smith, Blakely, Sr.—Agricultural consultant. (Mail) 2920 Rice Blvd., Houston 5, Tex.
- Smith, Lieu R.—2nd Lt., Corps of Engineers, U.S. Army. (Mail) Okeene, Okla.
- Sundstrom, Alfred C.—Partner, Riverina Spraying Service, PO Box 117, Wagga Wagga, NSW, Australia
- Sutton, Gerald W.—Engineer, The Hawthorne-Seving Co., Sidney, Ohio. (Mail) 306 Park St.
- Trevillyan, Robert J.—Staff engineer, U.S. Rubber Co., 6600 E. Jefferson Ave., Detroit 32, Mich.
- Tyson, Zariel G.—Assistant professor in agricultural engineering, New Mexico A. & M. College, State College, N. M. (Mail) Box 268
- Wachuta, Joseph R.—Technical assistant, Institute of Paper Chemistry, Appleton, Wis. (Mail) 1328½ So. Monroe St.
- West, William K.—Manager of agricultural application sales, Delco Products Div., GMC, 329 E. First St., Dayton 1, Ohio
- Wheaton, Rolland Z.—Graduate student in agricultural engineering, Michigan State College. (Mail) 1947 Chestnut, Holt, Mich.
- Whitaker, Joe B.—Lt., USAF. (Mail) Box 742, Olton, Tex.
- Witte, Richard E.—Field engineer, Tela Railroad Co., Tela, Honduras, Central America

Transfer of Membership Grade

- Brooker, Donald B.—Associate professor in agricultural engineering, University of Missouri, Columbia, Mo. (Associate Member to Member)
- Fineman, Abraham — Research fellow in agricultural engineering, Rutgers University. (Mail) North Branch, N. J. (Affiliate to Associate Member)
- Fisch, Harrison C.—Teacher and engineering adviser, Universidad Nacional de Colombia, Facultad de Agronomia, Palmira, Colombia, S. A. (Associate Member to Member)
- Maybin, A. H. Jr.—Instructor, Long Island Agricultural & Technical Institute, Farmingdale, N. Y. (Associate Member to Member)
- Myers, Julian M.—Associate agricultural engineer, Agricultural Experiment Station. (Mail) Agricultural engineering dept., University of Florida, Gainesville, Fla. (Associate Member to Member)
- Pos, Jacob—Assistant professor in agricultural engineering, Ontario Agricultural College, Guelph, Ont., Canada. (Affiliate to Associate Member)
- Wilkinson, Thomas J.—Agricultural engineer, technical service div., Ethyl Corp. (Mail) 1356 Bates St., Birmingham, Mich. (Associate Member to Member)

"Easy Chair" Corn Picker with Radio Attached

Everett and Norman Albaugh, near Ankeny, Iowa, demonstrate their "easy chair" corn picker to Texaco Man V. W. Smith. The "easy chairs" eliminate stoop labor; the radio, boredom. The Albaughs use Texaco Marfak lubricant on their tractor and farm machinery because it sticks to bearings better and longer. It won't jar off, drip out, dry out or cake up.



More evidence of Albaugh handcraft: This little "chariot," complete with mudguards, gives the Albaugh youngsters a fast spin when Fido is willing. Texaco Man Smith has just arrived with some Fire Chief, the gasoline with superior "Fire Power" for low-cost operation.

Out in the corn belt, a heavy windstorm can level a corn crop, necessitating hand-picking from the ground. This is hard stoop labor. Everett and Norman Albaugh who farm 420 acres near Ankeny, Iowa, figured that picking up corn sitting down was a lot easier than stooping.

They got busy with a welder, using some angle iron, two old mowing machine seats and the rear wheels of an old truck, and built themselves the "easy chair"

corn picker shown above. They toss the corn over their shoulders into a wagon behind them. Corn picking comes during the football season so they installed a radio to listen to the "Big Ten" games as they pick.

These enterprising farmers, like keen farmers and ranchers the country over, have found that it pays to farm with Texaco Products. They like the service they get from popular Texaco Men such as V. W. Smith.



On the highway or in town

Farmers and ranchers find it pays to stop by at Texaco Dealers' stations. For only Texaco Dealers have new top octane Sky Chief gasoline, Super-Charged with Petrox, to give maximum power and reduce engine wear . . . and famous Fire Chief, at regular prices, both 100% Climate-Controlled for top performance. You also get Advanced Custom-Made Havoline, the motor oil that wear-proofs engines for longer life.



Texaco PT Anti-Freeze saves time, bother and expense; one filling lasts all winter, gives safe anti-freeze protection; protects against rust; won't boil or foam away on warm days. Don Rogier (above) gets ready to put Texaco PT Anti-Freeze in radiator of Rogier truck. The Rogiers are served by Texaco Man Malcolm Herbst of Highland, Illinois.



See the interesting history of sheep raising . . . how sheep are developed and bred . . . how they're shorn. Your Texaco Man will tell you about the time and place of showing. Plan to bring your family. It's free, of course. Plenty of free prizes, too.



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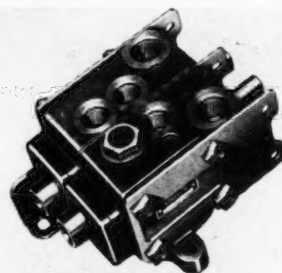


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Multiple-Unit Valve for Hydraulic Systems

Vickers, Inc., 1400 Oakman Blvd., Detroit 32, Mich., announces a new series of compact multiple-unit valves designed specifically for mobile machinery service, including farm implements. It is designated series CM 11. These new valves are made up of standardized and interchangeable units assembled in combinations (up to 8 sections) between special compact combination inlet and outlet units. The new inlet section is a single casting that combines inlet manifold, operating valve and relief valve. The new outlet unit is also a one-piece casting combining outlet manifold, operating valve and end plate. This combined form makes the valve physically smaller than would be pos-



sible using all separate sections. Individual end plates are also available for applications involving the use of a single operating valve.

The new series is available in double-acting and single-acting operating valves in addition to the combination inlet and outlet units. Single-acting valves are available for either direction of lever shift. O-ring seals provide leakproof joints between the mating faces of valve sections.

Two New Diesel Tractors

John Deere, Moline, Ill., announces two diesel tractors—Model 70 row-crop and 70 standard, both in the 4 to 5-plow tractor category. They will handle 12 or 14-foot double-action disk harrows, 20-foot disk tillers, and other large-capacity tools. Both are powered by a new diesel engine of exclusive John Deere two-cylinder design with special pistons and a forged steel crankshaft with three main bearings. An auxiliary en-



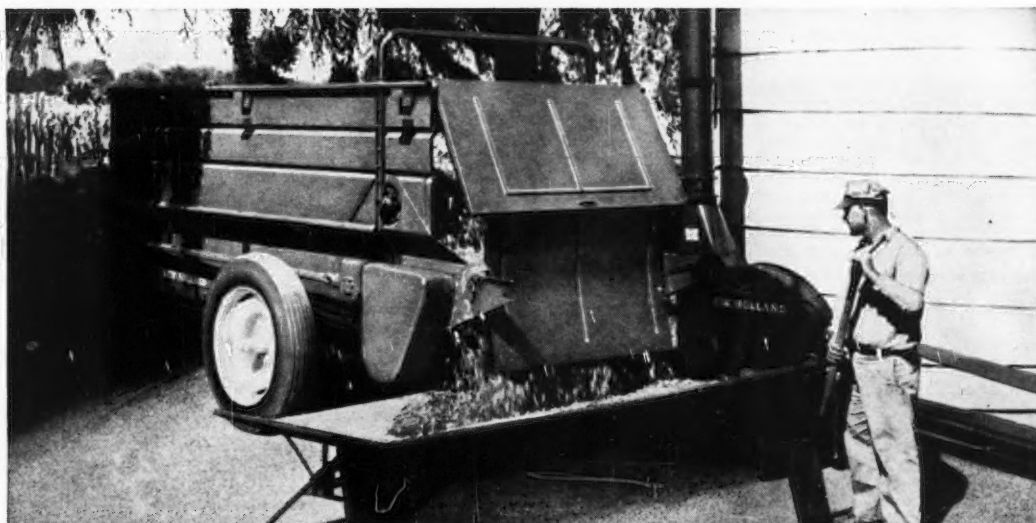
gine provides fast starting in cold weather, and a single lever controls the entire starting cycle.

These models have a quick-change, rear-wheel tread, the wheels being moved on the rear axles by a gear-and-rack action with a hand wrench. Factory-engineered power steering, live power shaft, roll-o-matic front wheels and 3-point hitch for pick-up-and-go tools are optional on both models.

(Continued on page 898)



Could the manure spreader



take on another job?

WHEN NEW HOLLAND engineers laid out plans for a new 130-bu. manure spreader, they took another look to see how they could give the farmer even more machine for his money. Here's the finished result.

First, this new spreader is the most advanced on the market today. An exclusive Uni-Lever gives independent control of beaters and apron speeds right from the tractor seat. Metalife primer protects the box inside and out. The dense Georgia pine flooring is treated with Pentacote. Power trans-

mission is made through a double-lined disc clutch.

Second, with extension sides and double-hinged end gate in place, the New Holland Spreader converts to a 3½-ton forage box that unloads silage automatically . . . no silage fork needed.

Production of this new double-duty spreader is another example of why New Holland is "First in Grassland Farming."

The New Holland Machine Co., New Holland, Pa. A subsidiary of The Sperry Corp.

NEW HOLLAND  *"First in Grassland Farming"*

New Products and Catalogs

(Continued from page 896)

Data Sheets on Flywheel Couplings

Morse Chain Co., 7601 Central Ave., Detroit 10, Mich., will send on request to interested readers copies of two new data sheets (FS-41-54) describing its Morflex industrial engine flywheel flexible-coupling units. These sheets illustrate and list specifications for standard units that will fit eight models of Chrysler industrial engines and twenty-nine models of Ford industrial engines. The units include a long-life, torsionally flexible, shock-resistant, weather-proof standard Morflex coupling and a balanced cast iron adapter plate that bolts to

the engine flywheel through the clutch bolt circle holes. The units are sold with the adapter plate drilled to suit the particular engine model and no drilling or machining is required by the customer.

Wear Properties of Ductile Iron

International Nickel Co., 67 Wall St., New York 5, N. Y., will send on request to interested readers a copy of its 4-page Bulletin DI-20, containing case histories supporting National Advisory Committee for Aeronautics test data showing ductile iron comparable to gray iron and in some cases better for wear-resistant applications. Examples of gears, bearings and die performance suggest other uses that involve stringent operating the loading conditions.

Heavy-Duty Hydraulic Ram

Char-Lynn Co., 2843 26th Ave., So., Minneapolis 6, Minn., advises that its heavy-duty "Strokontrol" ram incorporates an easily adjusted accurate hydraulic-depth stop. The thumb-screw collar on the piston rod can be set at any desired position to stop the retracting stroke at the given point until the collar position is changed. The ram utilizes



high-strength aluminum alloy castings, a hard chrome-plated piston rod, blocked V seals, and a honed barrel for precision operation. The double-acting cylinder has a 3½-inch bore and is available in stroke lengths up to 16 inches. It is designed for operating pressures up to 1200 psi and meets ASAE and SAE specifications governing hydraulic cylinders.

Hydraulic Loader

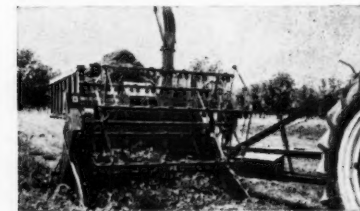
New Idea Farm Equipment Co., Coldwater, Ohio, has announced a new hydraulic loader designed for shorter wheelbase row-crop and small standard tractors. It retains



the features of the New Idea-Horn 50 conversion model, but has shorter cylinders and a frame 16 inches shorter. It is designed for Case VAC, VAC-14 and DC-4; also for the John Deere 40, Allis-Chalmers CA, and International Harvester Super C.

Cutter-Bar Attachment for Field Harvester

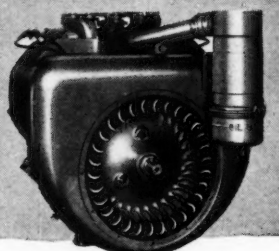
International Harvester Co., Chicago, Ill., announces it has developed a new 6-foot cutter-bar attachment for the McCormick No. 20-C field harvester, designed especially for farmers who, in a single, one-man operation, desire to mow and chop forage for silage or for feeding direct from the field.



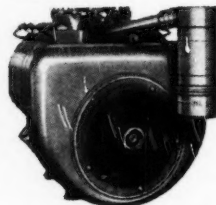
The cutter bar is interchangeable with the pickup hay and row-crop attachments for the harvester. In addition to the 6-foot cutter bar, the new attachment includes a 4-foot reel and an all-metal platform. The reel contains 96 coil-spring fingers to feed the standing crop into the sickle. Steel fingers in the bottom and sides of the platform gather the crop and guide it back to the feed apron in a smooth, even flow.

(Continued on page 900)

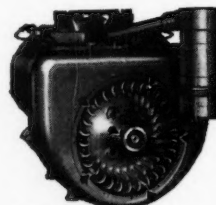
Only WISCONSIN Air-Cooling GIVES YOU ALL THESE BENEFITS



Open view of the powerful flywheel-fan on multi-cylinder models. Note depth and "scoop" design of fan blades . . . integrally cast as part of the flywheel. No delicate parts to invite damage.



Specially Designed Self-Cleaning ROTATING SCREEN over flywheel-fan intake opening, mounted directly on flywheel. Centrifugal force automatically throws off straw, hay, weeds or other trash that may come in contact with screen during field operation of equipment. Prevents clogging of fan, cooling fins and shrouding baffles. Rotating screen supplied as optional equipment when specified on factory orders.



Flywheel-fan showing simple, foolproof method of mounting Rotating Screen by means of stud bolts anchored in flywheel. Crankshaft collar provides snug closure at center without interfering with manual cranking.

AIR-COOLING, as supplied on ALL Wisconsin Heavy-Duty Engines, automatically takes care of all cooling problems, at all seasons of the year, at all operating temperatures up to 140° F., or extreme sub-zero temperatures. Nothing to freeze in cold weather, no hot-weather dry-ups. There is nothing for the operator to forget or neglect — no costly replacements because "someone forgot" to put water or anti-freeze in the radiator. It's foolproof!

AIR-COOLING, as compared with water-cooling, prevents engine failures and expensive replacements caused by heavy deposits of alkali in the radiator, water jackets and heads . . . in those areas where alkali is a serious water problem.

AIR-COOLING, as supplied on ALL Wisconsin Engines, is handled efficiently by ONE SIMPLE CASTING . . . actually the flywheel itself, of which the powerful fan is an integral part, working in perfect co-ordination with scientifically designed cooling fins cast into the cylinder block and head, and carefully engineered air baffles in the shrouding.

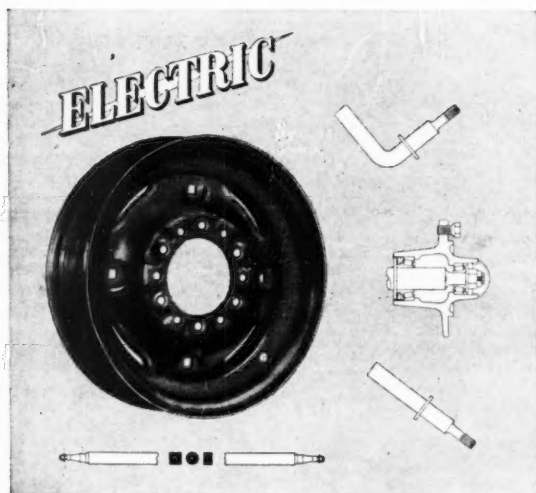
WISCONSIN ENGINE AIR-COOLING provides trouble-free cooling even under extremely dirty field conditions, when engine is equipped with our specially designed, self-cleaning ROTATING SCREEN which is available as optional original equipment.

These are just a few of the reasons why it pays to specify "Wisconsin Heavy-Duty Air-Cooled Engine Power" for your mechanized equipment. You not only get the most power service with the least servicing but you also get dependable "Lugging Power" that keeps the job moving when the going is tough. Write for Bulletin S-164, with specifications covering the full line of Wisconsin Engines, 3 to 36 hp.



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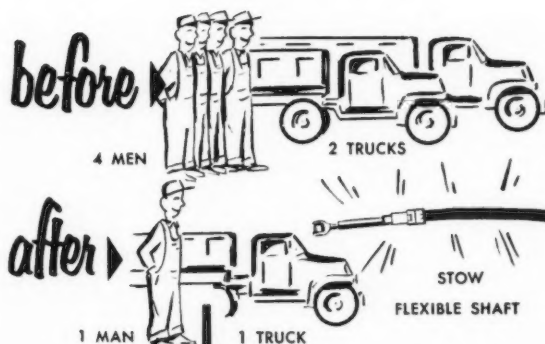
Accept no substitutes. Invest in Rain Bird for years of dependable sprinkler performance. Also, be sure that the installation of your entire sprinkler irrigation system meets the standards set by the American Society of Agricultural Engineers and fits your needs exactly.

Literature and information on request.

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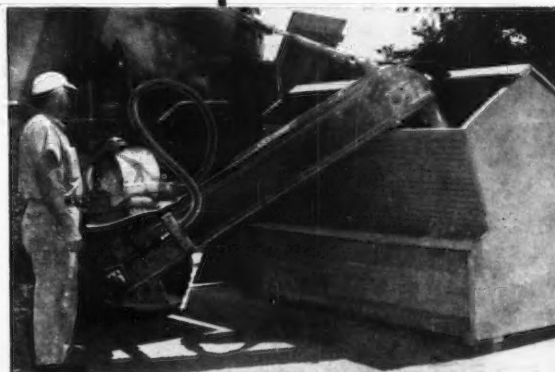


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shaft
makes
the
difference

Talk about efficiency... One man, one truck and one STOW flexible shaft now do the job that formerly required 4 men and two trucks—and in half the time!

Yes, a STOW flexible shaft makes the difference. Perhaps you can use STOW flexible shafting to advantage in some of the power transmission problems you are working on right now. STOW engineers are at your disposal. Check on the advantages of flexible shafting in connection with your next power transmission problem.

A STOW 1" shaft powers this feed conveyor which feeds 200,000 ducks on a Long Island Duck Farm each day. Formerly 4 men, 2 trucks were required to do the job.



Write today for FREE Engineering aids. This handy torque calculator and Bulletin 525 titled Engineering Data are yours for the asking. Write today on your company letterhead.



STOW

STOW MANUFACTURING CO.
39 Shear Street
BINGHAMTON, N. Y.

New Products and Catalogs

(Continued from page 898)

Twine-Tie Baler

John Deere, Moline, Ill., announces the new John Deere No. 14-T twine-tie baler which features a power-driven pickup that is 53 inches wide with an extra 8½ inches added by side flares, a large floating auger feeder which adjusts automatically to feed light or heavy crops, and a fork-type feeder to move the hay into the bale case and distribute it uniformly for well-formed bales. Other features include continuous-running plungerhead, simple adjustments to change length and weight of bales, bale



groovers which form twine channels in the bale and protect twine and prevent twine from slipping off the bales. The baler is available with a 15-hp auxiliary engine or as a power take-off model requiring only a 2-plow tractor for satisfactory operation.

This new baler will be produced and sold along with the company's Nos. 114-W and 116-W automatic wire-tie balers.

KOHLER ENGINES

4-CYCLE
AIR-COOLED



K160

K90 3.6 H.P.
K160 6.6 H.P.
K330 11.8 H.P.
K660 26.8 H.P.



K90

Kohler Engines are engineered and manufactured to the high standards which have made the Kohler mark known for quality the world over.

Power for garden tractors, pumps, sprayers, snow removal equipment, grain elevators, hoists, portable saws, concrete mixers, compressors, industrial lift trucks.

Write for information



K330

Kohler Co., Kohler, Wisconsin
Established 1873



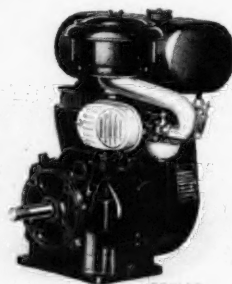
K660

KOHLER OF KOHLER

PLUMBING FIXTURES • HEATING EQUIPMENT • ELECTRIC PLANTS
AIR-COOLED ENGINES • PRECISION CONTROLS

Direct-Mounting Engine

Kohler Co., Kohler, Wis., announces that its K160, 4-cycle, air-cooled, gasoline engine is now available for direct-mounting applications. It is rated at 6.6 hp and is designated as Model K160P. The machine-faced crankcase and threaded power take-off shaft extension make the engine adaptable for direct mounting on pumps. The engine weighs 67 lb, includes stellite-faced exhaust valves and valve inserts, valve rotators, oil bath air cleaner, flyball governor, ball bearings at both ends of the crankshaft, and accessible dust proof and moisture proof breaker-point assembly.



KOHLER

This engine, designated K160S, is now available with electric starting. It is equipped with a 6-volt electric starter and generator, ignition switch and starter button.

Hydraulic Steering Booster

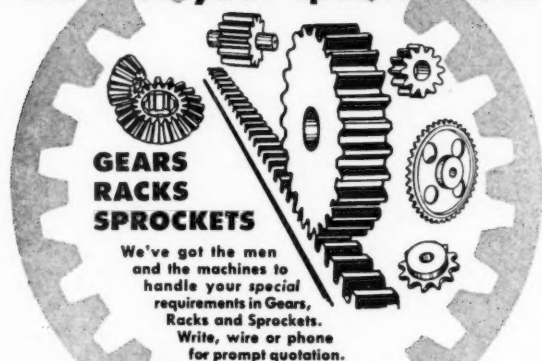
Vickers, Inc., 1400 Oakman Blvd., Detroit 32, Mich., announces a new compact hydraulic power-steering booster designed for wide application in mobile machinery. Designated as the Series S23, the booster is available either with or without relief valve, and can be either factory installed or mounted on vehicles in service. It can also be mounted interchangeably with the Vickers S6-270 series steering boosters, yet has a longer stroke. Installation of the unit is



made easier because of reduced diameter, in addition to mounting adaptability provided by a symmetrical control ball stud housing that can be assembled in any one of four different positions. The unit transmits all ground shock to the chassis so that the steering wheel cannot be jerked out of the driver's control when ruts or obstructions are encountered, which is an important safety factor.

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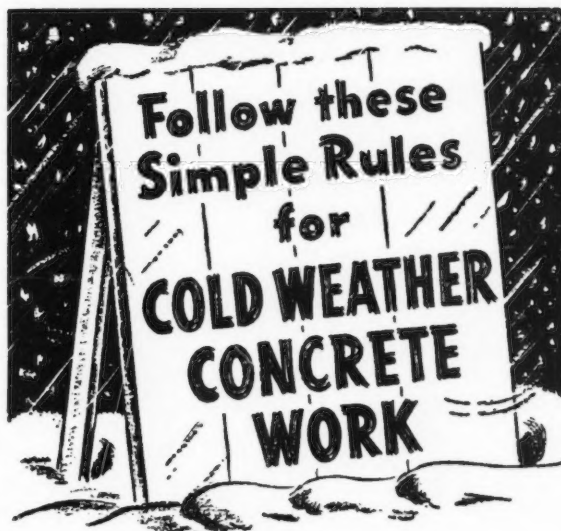
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AFTER the last crops are in farmers usually have more time for construction work. Concrete improvements can be built in winter just as well as in summer, but certain precautions must be observed. These are:

① **HEAT MATERIALS.** Concrete should be between 60° and 80° F. when placed in the forms. Heat sand and coarse aggregates separately until all frost, ice or snow disappears. The water should never be hotter than 175° F. when it comes in contact with the portland cement in the mix—otherwise a flash set may result.

In above-freezing weather heating the water or putting a heater on the mixer may be all that's necessary to bring up the temperature of the mix.

② **MIX CAREFULLY** so that concrete is as stiff as possible and yet will place and finish properly. Never add salts or chemicals to *prevent freezing*. Small amounts of calcium chloride (2 lb. per sack of cement) may be used to *accelerate the hardening*.

③ **CLEAN FORMS** of all frost, ice and snow.

④ **THAW GROUND** if it is frozen. Never place freshly mixed concrete on frozen ground.

⑤ **PROTECT CONCRETE FROM FREEZING.** Flat work can be protected with heavy paper and 10 to 12 in. of hay or straw. Walls and other structural members must be enclosed with canvas and kept warm. Do not remove forms until concrete has had time to harden properly. Normally concrete must be maintained at 50° F. or higher for five days after placing. However, with high-early-strength concrete this time period may be reduced.

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AGRICULTURAL ENGINEERS YEARBOOK

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Agricultural Engineers
including

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- 2 Agricultural engineers in state and federal employ who advise farmers in the selection and application of farm equipment of all kinds.
- 3 Engineers in soil and water conservation who specify methods, machines, and equipment in irrigation, drainage, and erosion control operations.
- 4 Agricultural engineers who spearhead advances in functional and structural design of farm-housing and crop-storage buildings.
- 5 Engineers who have pioneered the engineering applications of electricity on 90 per cent of American farms.

CONTENTS

The 1955 AGRICULTURAL ENGINEERS YEARBOOK will contain items of information which agricultural engineers frequently need to consult, the more important of which are:

- ASAE-approved standards, recommendations, codes, and data.
- Directory of manufacturers (1) of components, materials, etc., specified in designs for farm machines, structures, and other equipment, and (2) of complete machine and structural units used in farming and allied operations.
- Alphabetical and geographical directory of ASAE members.
- Roster of ASAE officers, divisions, sections, and committees, and other organizational information.

AGRICULTURAL ENGINEERS YEARBOOK will be found on the desk of every ASAE member where it serves as a ready reference throughout the year.

Reserve space NOW for the 1955 edition.

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NEW BULLETINS

Preventing and Controlling Water-Conducting Rot in Buildings, by A. F. Ver-rall. Southern Forest Experiment Station (Gulfport, Miss.) Occasional Paper 133 (June 1954).

Brief non-technical treatment of the incidence, identification and control measures for Poria rot which may attack lumber and lumber construction under favorable conditions, particularly in southern states.

Studies of Waste Water Reclamation and Utilization, by A. F. Bush and S. F. Mulford. State Water Pollution Control Board (Sacramento) Publication No. 9 (1954). A final report of 82 pages (8½x11 inches) dealing with (1) methods of use in relation to pollution of underground waters and to contamination of crops, (2) nuisances resulting from reclaimed waste waters and (3) general considerations of im-

portance in waste water reclamation programs.

NIAE Bulletins. The following have been published recently by the National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedfordshire, England.

A Tree Spraying Machine Report No. 36.
Potato Spacing Experiments—Report No. 38.

The Determination of the Moisture Content of Groundnuts—Report No. 39.

The NIAE Single Wheel Tester—Report No. 40.

Some Experiments on the Mechanical Extraction of Leaf Protein—Report No. 43.

The Drying of Oats in Sacks—Technical Memorandum No. 107.

Experiments in the Drying of Oats in Ventilated Silos—Technical Memorandum No. 108.

The Resistance to Airflow of Oats and Barley in Ventilated Bins—Technical Memorandum No. 109.

PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated.

POSITIONS OPEN—JUNE—O-181-628, 197-629, JULY—O-205-634, 209-638, 219-638, 222-639, 231-642, AUGUST—O-250-647, 251-648, 244-649, SEPTEMBER—O-276-650, 262-651, 293-654, OCTOBER—O-326-656, 332-657, 327-659, 353-660, NOVEMBER—O-374-661.

POSITIONS WANTED—JUNE—W-199-137, JULY—W-177-138, 224-141, AUGUST—W-237-142, 252-143, 265-144, SEPTEMBER—W-246-147, 266-149, 294-150, OCTOBER—W-296-152, 330-153, 340-154, 365-155, 349-156, NOVEMBER—W-369-157, 331-158, 372-159, 375-160.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEER, to take charge of research program in power and machinery at a state university. BS deg from an accredited college or university. MS deg desirable but not required. Liberal policy of allowing graduate work along with full-time research program. Assistant or associate professor rating depending on training or experience. O-403-662

AGRICULTURAL ENGINEER, to conduct research studies in irrigation at a state university. BS deg from an accredited college or university. Assistant professor rating. Experience in irrigation research necessary. Work involves cooperation with departments of horticulture, agronomy and plant pathology. O-403-663

AGRICULTURAL ENGINEER (a'st'ant rating) for research in irrigation and soil conservation at a southern land grant college. BS and MS deg in agricultural engineering, or equivalent, with research experience in supplemental irrigation and soil conservation. Normal opportunity for advancement. Opening effective January 1, 1955. Send personal data, grade transcripts, references and record of experience with letter application. Salary open, 12-mo basis. O-417-664

SERVICE AND SALES ENGINEERS (2) for field work in farm buildings and farmstead planning with professional farm management organization in Midwest. Work involves co-ordinating management, capital, equipment, livestock, and buildings into good working and productive systems. Indirect selling. Approximately one-half travel. One location Midwest, one shallow South. Age 25-32. Prefer training in agricultural engineering with farm structures major and good general foundation including economics and farm management. Farm background. Experience desirable in farm management, farm sales and service, or dealer selection and training. Must enjoy meeting and working with people, have good common sense, and be able to make decisions and keep clients happy. Good opportunity for men able to organize and handle a large volume of work and handle people successfully. Salary open. J-412-665

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER expecting to graduate in February, 1955, available about Feb. 1, for sales and service work in power

and machinery or soil and water field, with manufacturer, distributor, or farming operation. Any location. Married. Age 25. No disability. Experience in part time work while in school including clerking for retail ice cream business, 2 yr; selling medical insurance, 6 mo; laboratory assistant in college agricultural engineering department, 6 mo; and laboratory assistant, agricultural experiment station, 5 mo; or weed control and general farm equipment repair and maintenance. Salary open. W-400-161

AGRICULTURAL ENGINEER for development, research or writing in power and machinery or product processing field with industry or public service in the Southwest. Will travel part time. To be married soon. Age 29. No disability. BS deg in agriculture 1950, BS deg in mechanical engineering 1951, University of Maryland. Farm background. Taught food processing 2 yr part time, University of Maryland. Taught agricultural engineering courses one year, University of Delaware, and served as extension agricultural engineer at same time. Farm equipment retailer, 2½ yr. War enlisted and commissioned service, Navy. Available now. Salary \$5000. W-371-163

AGRICULTURAL ENGINEER for design development, research, extension, or teaching in farm structures field, in public service or with manufacturer, anywhere in U.S.A. Married. Age 49. No disability. BS deg in architectural engineering, 1930, Iowa State College. Iowa license in structural engineering, 1933. Grew up in rural and urban construction business. Construction and repair supervisor in farm mortgage department of life insurance company, 5 yr. With farm department of laminated wood rafter manufacturer, 7 yr. With laminated team, arch and truss business, partly in farm buildings field, 5 yr. Currently in research laboratory of building material trade association. Available in February. Salary \$500 mo. min. W-391-164

AGRICULTURAL ENGINEER for extension, teaching, or research in rural electric or product processing field, in public service, anywhere in U.S.A. Married. Age 26. No disability. BS deg in agricultural engineering, 1954; MS deg in agricultural engineering expected March, 1955. Virginia Polytechnic Institute. Farm background. Part time and summer rural electric research in state agricultural experiment station, 2½ yr. Enlisted service in Army, 33 mo. Available April 15, 1955. Salary open. W-409-165

AGRICULTURAL ENGINEER for design development, research, sales, or service with industry, anywhere in U.S.A. Willing to travel. Single. Age 28. No disability. BS deg in agricultural engineering, 1948, University of Tennessee. Farm background. Taught adult farm classes 2 yr. Engineer on irrigation project in Southwest, 6 mo. Enlisted service 2 yr. in research and development work as specialized professional personnel. Enlisted and subsequent civilian research and development work as project engineer with army 3½ yr. on soil stabilization and special construction equipment for roads and airfields. Available on 2 weeks notice. Salary open. W-411-166

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Professional Directory

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Contents includes (1) ASAE-Approved Standards, Recommendations, and Engineering Data; (2) Directory of Suppliers to Agricultural Engineers; (3) Roster of ASAE Members; (4) List of ASAE Officers, Divisions, Sections, and Committees. Published by the American Society of Agricultural Engineers, this publication is an essential and frequently consulted reference source for every agricultural engineer, as well as for any individual, organization, or library in need of the particular information it contains.

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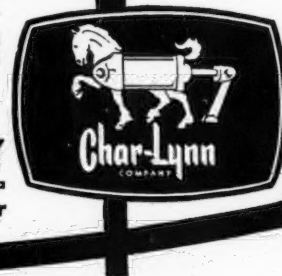
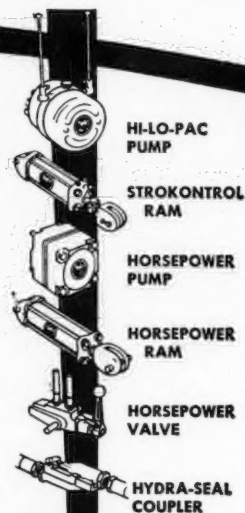
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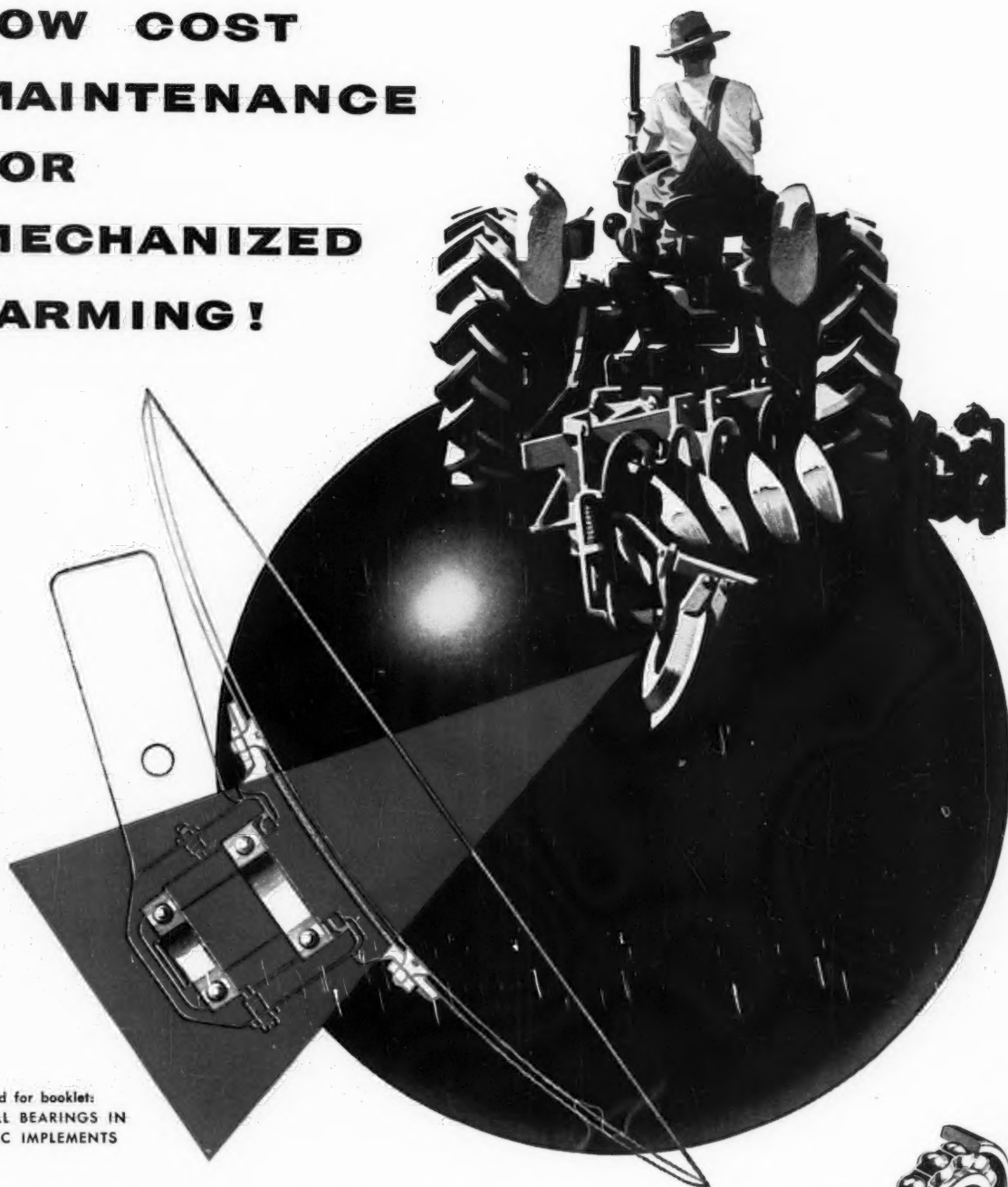
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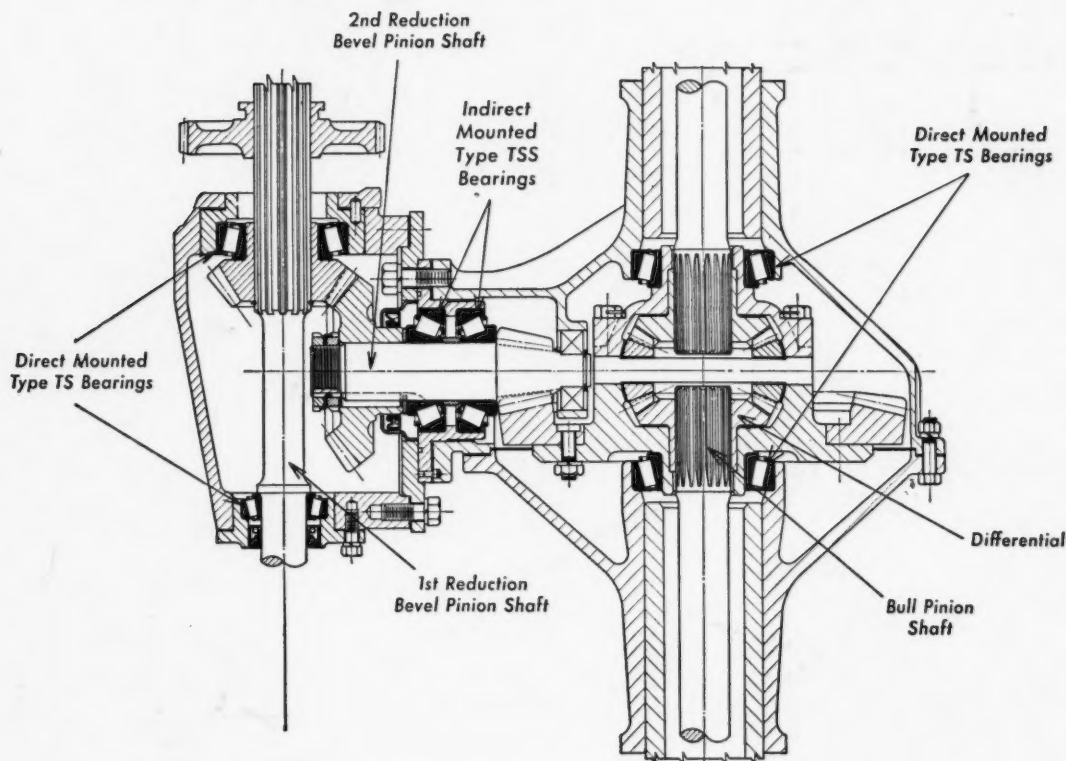


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How Timken Bearings Help John Deere Whip Combination Radial and Thrust Loads in Double Reduction Axle



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Each shaft carries at least one bevel gear. Timken bearings easily handle the resulting combination radial and thrust loads without special thrust bearings. The tapered construction of Timken bearings enables them to take *any* combination of radial and thrust loads.

Because Timken bearings hold housings and shafts

concentric, seals are more effective. There's no shaft wobble. Lubricant stays in—rice field mud stays out.

Timken bearings normally last the life of the combine. One reason: they're made out of the world's finest bearing steel—our own. It's an extra quality control that no other bearing manufacturer can give you.

For additional interesting information about Timken bearings, write now for your free copy of "Tapered Roller Bearing Practice in Current Farm Machinery Applications". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian Plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

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NOT JUST A BALL  NOT JUST A ROLLER  THE TIMKEN TAPERED ROLLER  BEARING TAKES RADIAL  AND THRUST  LOADS OR ANY COMBINATION 